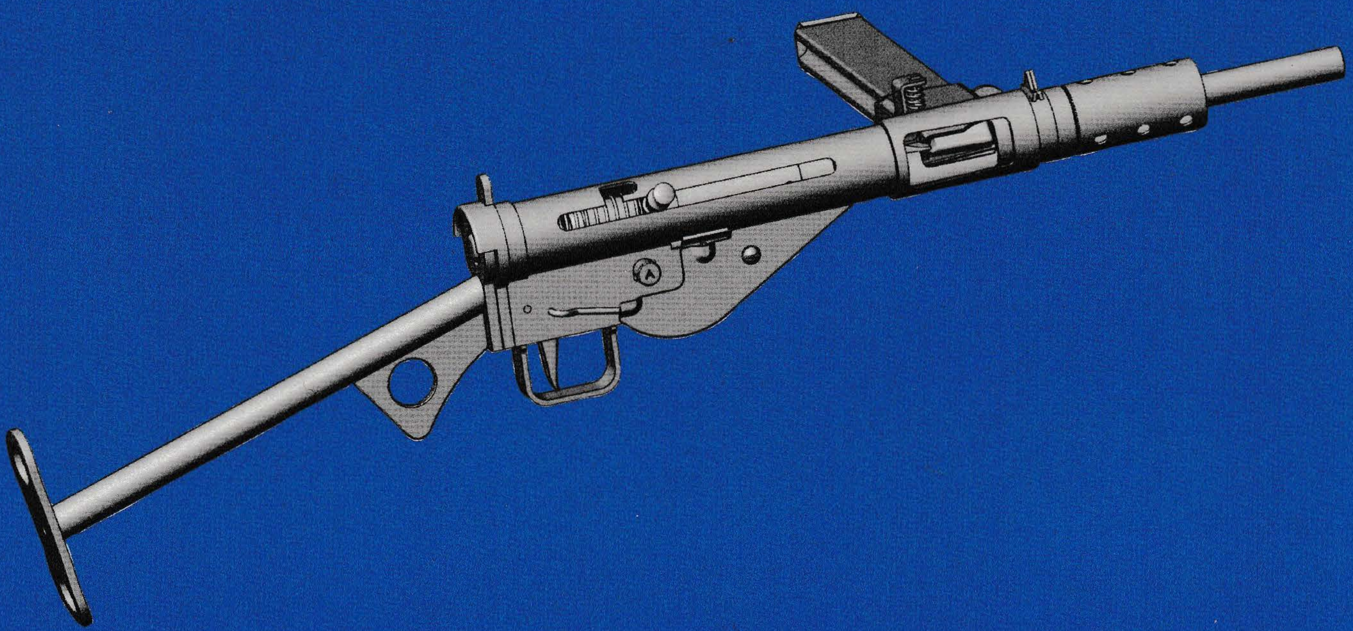
FIREARM ANATOMY • BOOK II

The Sten Submachine Gun



David S. Findlay

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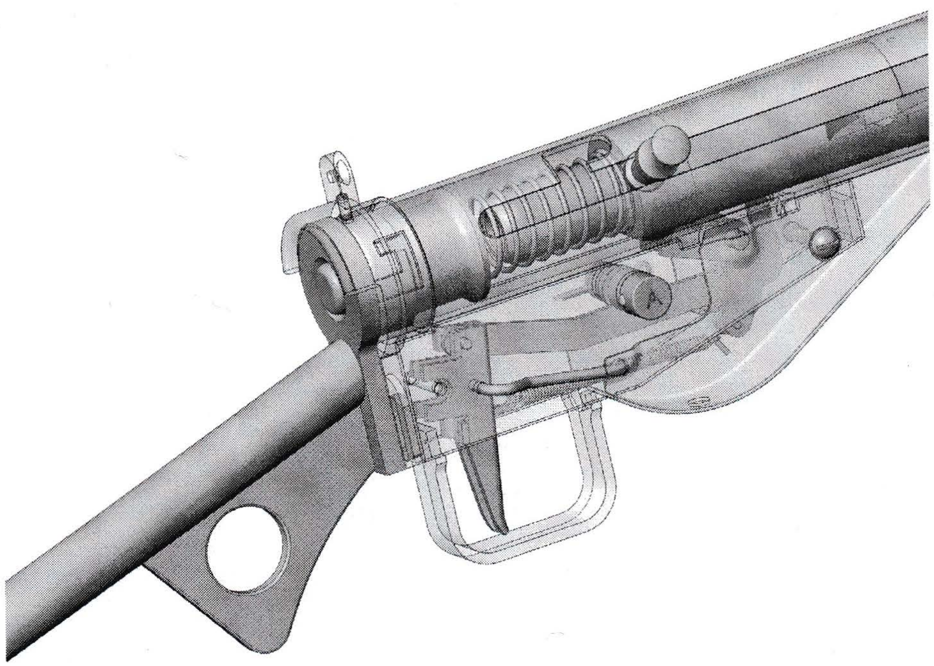

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David S. Findlay

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Dedication

To my spouse, Donna Findlay,
darling wife, best friend,
and mother to our children.

WARNING!

The legal possession of an automatic firearm is controlled by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) division of the US Department of Justice. Proper application to ATF must be secured before an individual can own and operate this type of firearm. Severe penalties are authorized for violators of these laws.

This book offers information for the academic study of firearms design. The author disclaims any responsibility or liability for the improper or illegal use of this information for the construction of an automatic firearm.

This manuscript has been reviewed by the Department of Defense for technical data as defined in the International Traffic in Arms Regulations (ITAR) and has been **approved** for public release. Export of this material is **not** restricted by the Arms Export Control Act, and this material may be exported or transferred to non-U.S. persons without prior written approval from the U.S. Department of State. This approval for release does not imply Department of Defense endorsement or factual accuracy of the material.

Contents

Preface

As with my first book, which was on the Thompson submachine gun, this book was written to generate people's interest in gun design.

As I indicated in the first book, the gun industry needs and is due for the next big breakthrough. Every 100 years seems to bring the next significant development in firearms technology. In the 1600's, the wheel lock was developed and heralded the first use of firearms. In the 1700's came the flintlock musket. In the 1800's came the percussion cap and, later in the century, the thin brass shell used to carry the powder, bullet, and primer was perfected. While the 20^{th} century has seen the invention of liquid propellant, caseless ammunition, and the gyrojet, the thin brass shell has been hard to beat and is still the dominant way to feed ammunition to the firearms of today. We are due for the next advance, but from where will it come?

Gun design lends itself to one designer/engineer with a vision, many times helped by a team of draftsmen and model makers. Most of the truly successful gun designs of the past century were developed in this way. Sometimes these men were able to form companies based on the guns they devised. Hopefully this book will interest you in both the simplicity and the hidden complexity that good gun designs exhibit and prompt you to investigate the field of firearms design further.

The first book dealt with finding the rpm level of the Thompson in three different ways, showed how to design an oval magazine spring, explained how the Thompson worked, and gave a complete technical data package for the gun. In this book, you will also find two of the three ways to calculate the rpm level of the Sten but giving you the necessary cartridge data for 9mm ammunition in order to have the results come out correctly. You will also be given an explanation of how the Sten operates and again a complete technical data package for this firearm. New areas that will be covered will be material selection and heat treat for various common firearm components and an explanation of how to analyze and design a gun barrel. In addition, I give you a resource to find the pressure versus time curve of any cartridge including any design for a new round that you conceive of without the need for expensive test equipment and time.

You will find, and hopefully have already noticed, that the rpm level of both the Thompson and the Sten are different from the published results. You should also have noticed that experimental data agrees more with the calculated results than published results. This is most likely due to difference in ammunition and powders used during the war years versus ammunition used today or the techniques they used in the past to measure rpm levels. In any event, the math presented (and the Excel files in the appendix which use that math) is important as it will reduce the prototyping time necessary for a new more modern blowback design that is being contemplated for a semi-automatic or automatic firearm.

Acknowledgments

I would like to acknowledge the people who shared their valuable time and expertise to comment on various parts of this book. These include John Avedisian, a metallurgist who works with me at Smith and Wesson, and whose expertise I value. Jack Simon, a talented product engineer at Smith & Wesson, volunteered to review the book and his help was most appreciated. I also need to thank Lois Chase at Smith and Wesson who helped with the illustrations. Many thanks need to go to Nancy Ovedovitz, my sister-in law, who did the cover. I would also like to thank my mother, Marie Findlay, who has corrected my wording since I wrote my first papers back in elementary school and who once again came through to help me with this effort.

Again, I want to thank my wife, Donna, who has put up with me working on this second book. She has always been supportive. Finally, I would like to thank my father, David Findlay, who, for many years, worked for Winchester Repeating Arms, then for Bellmore Johnson Tool Co., and finally for himself at Guilford Engineering Associates, being both a gun designer and a firearm product liability expert. My father has helped my understanding of firearms immensely and has been a helpful confidant and mentor in all my endeavors, working at Remington, Marlin/H&R 1871, and now at Smith and Wesson. He again made supportive suggestions for this book.

The Sten Gun
by Gunner. S.N. Teed[1]

You wicked piece of vicious tin!
Call you a gun? Don't make me grin.
You're just a bloated piece of pipe.
You couldn't hit a hunk of tripe.
But when you're with me in the night,
I'll tell you pal, you're just alright!

Each day I wipe you free of dirt.
Your dratted corners tear my shirt.
I cuss at you and call you names,
You're much more trouble than my dames.
But boy, do I love to hear you yammer
When you're spitting lead in a business manner.

You conceited pile of salvage junk.
I think this prowess talk is bunk.
Yet if I want a wall of lead
Thrown at some Jerry's head
It is to you I raise my hat;
You're a damn good pal...
You silly gat!

Imperial War Museum,
H 10688
Winston Churchill takes aim with a Sten gun during a visit to the Royal Artillery experimental station at Shoeburyness in Essex.
June 13, 1941

Chapter 1
The Sten's Creation and Designers

Your country is at war. It has not gone well. You are alone. France is in the hands of the enemy. You have managed to save the army but most of their guns, tanks, and material were left on the shores of France. Your nation's soldiers do not have enough guns to defend your shores as you await an invasion you and your countrymen believe is imminent. You are involved in the design of firearms and are an experienced designer. Need any more motivation?

At the time when Great Britain entered the war, in 1939, she had no submachine gun of any type for her military force.[2] The Thompsons coming from America were reliable and effective but there were not enough of them and they were expensive.

Major Reginald Shepherd, chief superintendent of armament design, and draftsman Harold Turpin were ordered to prepare manufacturing production drawings from a working example of a captured German MP 28 because the need was so great and there was no time to develop Great Britain's own gun. This was the low-risk alternative. At the same period in time, George Lanchester was developing the Lanchester submachine gun, again a copy of the German MP 28. The Lanchester uses a 50-round magazine box approximately the same shape and form as the Sten's 32-round magazine box and was used exclusively by the British navy.

Gun development time was shortened on the Sten and on the Lanchester by copying the design of a German magazine box in use. This both helped and hurt the Sten gun's performance as I will discuss later. In normal times, magazine box development can take as long as the entire gun in terms of design, testing, and functional acceptance. But these were not normal times, and Harold Turpin designed and had first prototypes of the Sten in 36 days, an extraordinary effort.[3] It was obvious that he spent a great deal of effort designing at home as well as at his office. Already having the magazine box design complete, though, was a tremendous aid. Essentially, he was designing the mechanical mechanism around the magazine.

The whole objective was to reduce the time needed to make a submachine gun, reduce its cost, and not use scarce premium grade steels that were needed for other weapons. Style and beauty were not the concern that they would be in a commercial effort. Rugged and cheap were all that mattered. The Sten had issues in terms of safety and reliability that would have precluded it from being adopted in peacetime, but these could be overlooked in time of war.

Two other individuals who helped with the Sten were Alfred Holden, whose name can still be seen on the original blueprints, and Walter Sandwell, who was the special projects officer.[4] Once again, as with the Thompson submachine gun, the development of the Sten proved that a small team of dedicated individuals working on a high-priority project with assistance from other engineers and model makers can achieve impressive results in a short period of time if they are given support and are highly motivated.

The following is a timeline for the Sten's development from initial program concept to the Mark II model.[5]

Sten Development Timeline

Date	Activity	Comment
May 27 – June 4, 1940	The British suffer a huge loss of material and weapons on the shores of Dunkirk, France but manage to save the army.	Great Britain is in desperate straits.
Late 1940	Major Reginald Shepherd and draftsman Harold Turpin are ordered to prepare manufacturing production drawings from a working example of a captured German MP 28.	Alloy steel and machining capacity are in short supply in Great Britain
December 2, 1940	Harold Turpin comes up with the concept for the Sten's trigger mechanism.	See the patent explanation in the appendix.
December 3 - 10, 1940	Harold Turpin asks for and is given permission to design a new submachine gun that is less expensive than the Lanchester or the Thompson submachine. It will use the German MP28 / Lanchester magazine design in a 32-round configuration and will be side mounted like the Lanchester.	Turpin works at home as well as at the office to get the gun designed quickly.
January 8, 1941	First prototype is complete.	36 days between initial concept and first prototype of the Sten Mark I design
January 10, 1941	First official firing of the prototype weapon is complete.	
February 1, 1941	General staff directs the ministry of supply to order 100,000 Sten submachine guns	
February 7, 1941	Manufacture of pilot models gets underway.	
March 7, 1941	The Sten Mark I carbine is approved for issue.	
March 24, 1941	Paratrooper model of the Sten is requested.	

Date	Activity	Comment
March 31, 1941	Sten Mark II is completed. The cosmetics were changed but the basic design remains the same. The changes result in a less expensive gun and a gun that could be made more compact	Harold Turpin again works at home after hours to complete the design.
June 29 - July 1, 1941	Initial trials of the prototype Mark II Sten take place	
August 1941 through March 1945	2,600,000 Mk II Stens contracted for and produced	
April 1, 1942	A second contract for 100,000 MK I Stens is awarded	
October 22, 1942	A third contract for 100,000 MK I Stens is awarded	
1943	Peak production is reached when 47,000 are produced in one week.[6]	Total production from the start of manufacture in mid-1941 to late 1945 was approximately 3,750,000. 34,000,000 magazines were made.[7]

One observation that can be made is that the British government was willing to place an order for guns even before the prototypes had been fully developed. Today, this would be an extreme example of what is commonly referred to as "*-concurrent engineering-*". Concurrent engineering has advantages and disadvantages. Its main advantage is to bring products to market more quickly. One of its main disadvantages is that too often, design changes or changes in design scope will cause more money to be spent on testing and capital tooling to produce the product. Many times the design team needs extra time before the preliminary design is turned over to manufacturing for tool design and tool construction; otherwise money can be spent for tooling that is unusable or no longer needed. When the timeline is pushed there is also a tendency for the designer or design team to cut corners in the engineering analysis or the tolerance studies. This needs to be avoided as time spent on both of those areas pays dividends later on in the program.

Again, as in all design efforts, good communication between the design team and the manufacturing engineering team aids in a design that is not only functional but also cost effective. Having management experienced in product design and in the design process also is beneficial as they understand the pressures and can help be a sounding board for the critical design decisions that arise.

Library and Archive of Canada
Corporal Victor Deblois of Le Régiment de la Chaudière guarding German prisoners on Juno Beach, Bernières-sur-Mer, France, June 6, 1944

rman

Chapter 2
RPM Technical Analysis
Considering Friction and Elasticity

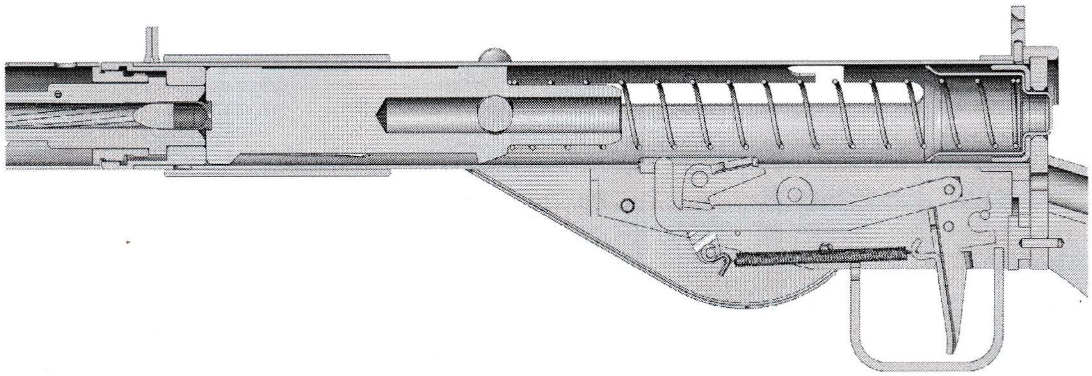
The starting point for the technical analysis of the Sten's design is the question of bolt velocity, which drives many of the system requirements. There has to be enough velocity for the firearm's bolt to travel the length of the receiver to allow consistent feeding and to stop on the sear—the component that stops the firearm from firing further if the trigger is no longer depressed. Bolt recoil velocity in a blowback-operated firearm is dependent primarily on the mass of the recoiling components. Its counter-recoil velocity is dependent on the mass of the recoiling components and the gun's drive spring. These two velocities, added together, determine the cyclic rate of the firearm or its round per minute (rpm) level.

For hand held weapons, rpm values from 450 to 950 are what most designers try to achieve for the best controllability of the firearm. In blowback submachine guns, where there is no locking system, rpm values are at the lower end of this range and generally should not exceed 700 rpm. Full automatic firearms with locking systems can achieve higher rpm levels safely but will have controllability issues unless compensated for by the design in some manner.

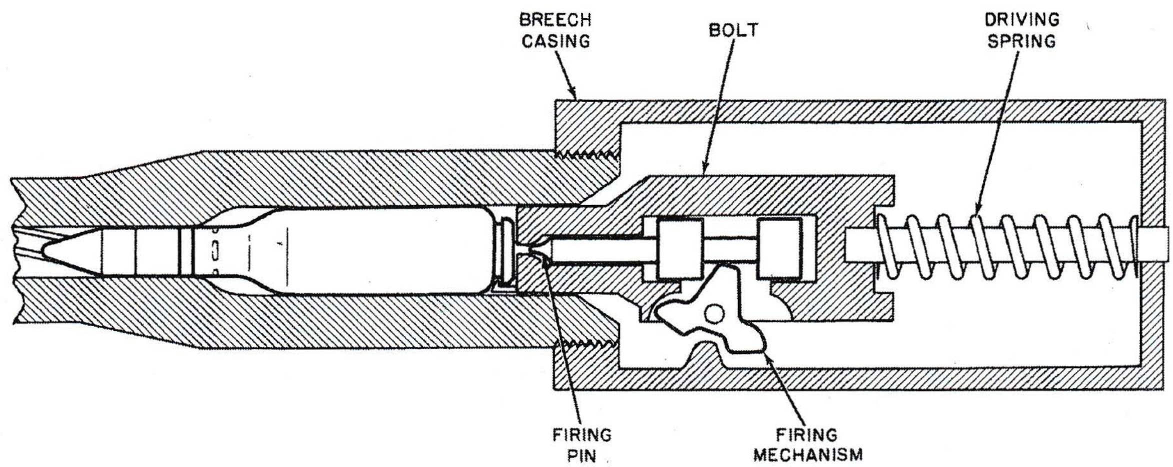
The Sten is a pure blowback automatic submachine gun. A pure blowback design has no locking system to hold the pressure of the fired ammunition. The inertia of the breech bolt provided by its weight is used to delay the opening of the firearm until the pressures are low enough for the case to be extracted safely from the gun. This type of design is very cost-effective because no complicated locking system is used to restrain the bolt to the barrel during firing. This design eliminates the need for additional locking components, with the accompanying added costs, due to tight tolerances and cam surfaces. The bolt weight and, to a much lesser degree, the action spring are all that is required to keep the bolt held forward sufficiently until the powder pressure reaches safe limits and then lets the action open. The round is fired when the breech bolt drives the cartridge forward into the chamber. The chamber stops the cartridge and the bolt's fixed firing pin geometry impacts and drives into the cartridge primer causing ignition.

Some have described the Sten as an "-advanced primer ignition-" design.[8] This claim is based on the belief and assumption that the breech bolt is still moving forward a small amount when the primer is ignited to fire by the bolt's fixed firing pin even though the round is fully chambered and at rest in the barrel. To describe the Sten as an "-advanced primer ignition-" design is technically incorrect. Advanced primary ignition refers to a gun operating system where the primer is ignited before the cartridge is fully inside or stopped by the chamber. In an advanced primer ignition system weapon, the momentum imparted to the bolt is only one-half of that which would be obtained with plain blowback. That means from this standpoint alone, the bolt weight can be reduced by a weight reduction factor of 2 to 2.5.[9] This is one of the primary reasons it is employed even though the mechanism is more complicated and expensive.

Sten Section View – Simple Blowback Design



Section View – Blowback Design with Advanced Primer Ignition [10]



This is not the case for either the Sten or the Thompson submachine gun. Two of the best examples of advanced primer ignition are the Oerlikon 20 mm cannon and the MK 108 cannon. In these weapons, the cartridge is not stopped in the chamber and the cartridge case is not fully seated in the chamber before primer ignition occurs by the firing mechanism. A primer is ignited either mechanically or electrically by timing the breech bolt's forward motion at a certain point in the gun's counter-recoil cycle for primer ignition. As will be shown in the following technical analysis, good results are obtained for the round per minute level by not considering advanced primary ignition and by considering the Sten gun as a simple blowback design utilizing all of the cartridge's impulse to drive the bolt to the rear. This also simplifies the analysis.

The firing cycle begins with the indenting of the primer in the cartridge case by the fixed firing pin protrusion on the face of the Sten breech bolt. When ignition occurs, the bullet is expelled from the cartridge, moves through the barrel, while the breech bolt, pushed by the cartridge case, moves in the opposite direction. Both the breech bolt and the bullet are subject to the same force for the same time by the burning of the propellant charge in the cartridge. The sum of all the products of the force multiplied by the time increment is called the *impulse* (expressed in lb-sec) and is applied equally to both the breech bolt and the bullet. Because the bullet has a much lower weight than the breech bolt, it travels much faster and farther than the bolt does in the same time period, but in the opposite direction. This system works only when the breech bolt is of sufficient weight, compared to the bullet, that it does not allow the cartridge case to move too far out of the barrel chamber. If this does occur, the case will rupture and fail because it is unsupported. In practice, blowback guns use ammunition with sturdy cases that are relatively short and have favorable pressure–time characteristics. This usually limits blowback weapons to pistol ammunition. There are exceptions to these limitations, but this is the general rule and practice.

The pressure from the powder gases of the fired cartridge can be measured using piezoelectric devices mounted on test barrels, designed for that purpose. These devices relate those pressures back to the time at which they occurred in the barrel. This equipment is not available to many but fortunately there is a solution to getting the necessary pressure-versus-time data for the gun designer. That solution is QuickLOAD software from Neco[11].

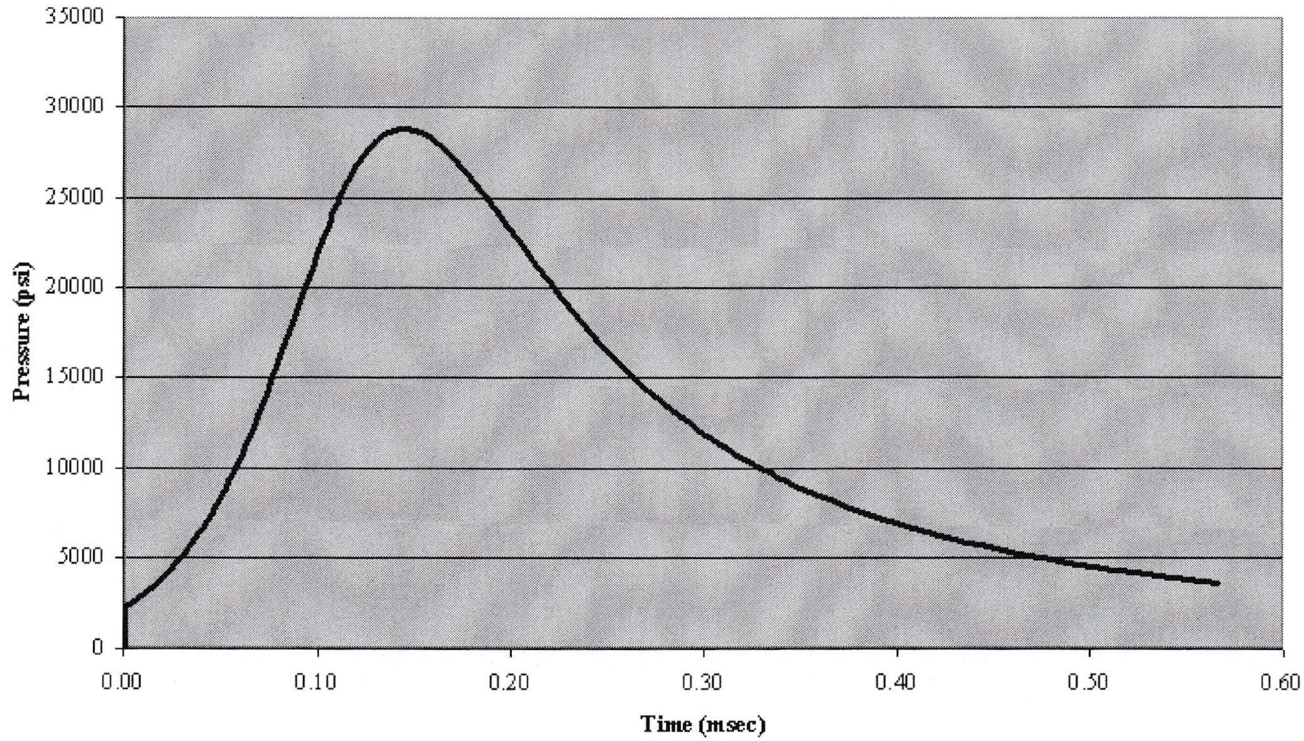
QuickLOAD is the best interior/exterior ballistic prediction software. It provides accurate results for more than 1200 cartridges, 250 powders, and 2,500 bullets. It can accept user-defined data for user-created wildcats. QuickLOAD instantly calculates pressures and velocities based on thermodynamic modeling as opposed to numbers crunched from loading manuals. The data generated can then be used by the QuickTARGET portion of the program to determine trajectories, wind deflection, sight corrections, down range velocity, down range energy, and a multitude of other useful outputs. The QuickLOAD/QuickTARGET interior/exterior ballistics programs have unique capabilities. Unique user-designed cartridges can be set up using QuickDESIGN, a cartridge designing program and then can be imported into QuickLOAD/QuickTARGET for interior and exterior ballistic analysis.

Using QuickLOAD software, a pressure-time curve for a typical 9mm-caliber round using a 115-grain bullet and 6 grains of a current modern powder, yielded a maximum pressure of approximately 28,800 psi. The pressure data for this 9mm round is shown below and graphed. The area beneath the pressure-time curve helps us calculate the round's impulse, and we will use this impulse to obtain the rpm (round-per-minute) level of the Sten.

Sample 9mm Pressure versus Time Data
115 grain bullet 6 grains powder

Time (msec)	Pressure (psi)		Time (msec)	Pressure (psi)		Time (msec)	Pressure (psi)
.0000	0		.1134	25,490		.2047	22,487
.0001	2,176		.1203	26,789		.2126	21,346
.0011	2,320		.1269	27,734		.2210	20,175
.0039	2,512		.1333	28,361		.2298	18,988
.0073	2,763		.1395	28,703		.2393	17,795
.0114	3,090		.1426	28,777		.2493	16,607
.0161	3,510		.1466	28,786		.2601	15,431
.0214	4,043		.1441	28,791		.2718	14,276
.0270	4,701		.1445	28,793		.2843	13,150
.0330	5,500		.1447	28,793		.2980	12,057
.0393	6,460		.1448	28,793		.3130	11,004
.0458	7,592		.14485	28,973		.3294	9,994
.0524	8,903		.1449	28,793		.3476	9,032
.0591	10,397		.14495	28,793		.3676	8,119
.0658	12,061		.1510	28,682		.3900	7,259
.0726	13,877		.1572	28,370		.4152	6,452
.0794	15,813		.1634	27,883		.4435	5,700
.0861	17,821		.1698	27,244		.4756	5,003
.0929	19,852		.1763	26,475		.5124	4,361
.0997	21,843		.1830	25,597		.5546	3,774
.1065	23,734		.1899	24,628		.5662	3,635
.1133	25,466		.1972	23,586			

Pressure vs. Time 9mm FMJ
Bullet Weight = 115 grains
Powder Charge = 6.0 grains



So how do we get the Impulse (Ip) in lbs-seconds, and why do we need it?

From Newton's Second Law:

$$\text{Force (F)} = \text{Mass } (m) * \text{Acceleration (a)} = m(\text{a})$$

But:

Acceleration (a) is equal to the change in Velocity(V) divided by the difference in time(t):

$$a = \frac{V_2 - V_1}{t_2 - t_1} = \frac{\Delta V}{\Delta t}$$

Therefore:

$$F = m \frac{\Delta V}{\Delta t}$$

And therefore:

$$F\Delta t = m\, \Delta V$$

Impulse is known as the product of the average force during the time it acts (the left side of the equation) and is equal to the change in momentum (M) (the right side of the equation).

$$Ip = F\Delta t = m\, \Delta V$$

In our case, the force (F) is equal to the change in pressure (Δ P) multiplied by the area of the head of the shell casing, which is pi (π) times the radius (r) of the shell head squared.

$$F = (P_2 - P_1)(\pi)(r^2)$$

Therefore:

$$(\Delta P)(\pi)(r^2)\, \Delta t = m\, \Delta V$$

The mass (m) of the system is the weight of the bullet divided by gravity plus half the weight of the propellant gases divided by gravity. The reason that only half of the powder gases are used is that as the bullet goes down the bore, the center of gravity of the gases travels only half the change in distance that the bullet does, so the velocity of the powder gases is half that of the projectile. Once the projectile leaves the muzzle of the barrel, the powder gas velocity is actually greater than the projectile by a factor of 1.5 times the projectile velocity, but inside the barrel, the following is true:

$$m = \frac{W_{bullet}}{(7000)/g} + \frac{W_{powder}}{(2)\,(7000)/g}$$

where 7,000 grains/lb is the conversion factor to convert the bullet and powder weight in grains into pounds. The gravity constant, g, is 32.2 ft/sec^2.

Now, solving for Velocity (V), in our case the velocity of the bullet, we get the following:

$$\Delta V = \frac{F\Delta t}{m} = \frac{(\Delta P)(\pi)(r^2)\,\Delta t}{m} = \frac{(\Delta P)(\pi)(r^2)\,\Delta t\,(g)}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

$$\text{Or} \quad = \frac{Ip\,(g)}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

And with: $\quad \text{Distance } (\Delta D) = \frac{\Delta V}{\Delta t}$

We can solve for the distance the bullet travels in the bore of the barrel by using the following equation and relationship:

$$\text{Distance } (\Delta D) = \frac{(\Delta P)(\pi)(r^2)\,(\Delta t)^2\,(g)}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

$$\text{or} \quad \text{Distance } (\Delta D) = \frac{Ip\,(g)\;\Delta t}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

With the preceding data and analysis, we can determine several important characteristics of the gun, among them the impulse of the round acting on the bolt breech face, the bullet velocity, travel of the bullet, and the pressure versus barrel length curve. To see the actual calculations please see Appendix II.

9mm Pistol Cartridge

Typical Projectile Weight (grains) =	**115.0**	**Inputs in Grey**
Typical Powder Charge (grains) =	**6.0**	
Cartridge Diameter (in) =	**0.354**	
Cartridge Area (in2) =	**0.098**	

Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
0	0	0	0.0000	0.0	0.0	0	0
0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000
0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000
0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000
0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000
0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000
0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001
0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001
0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002
0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004
0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006
0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008
0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012
0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016
0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022
0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029
0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037
0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047
0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058
0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072
0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088
0.1133	25466	24,600	0.0165	31.4	242.9	0.019	0.107
0.1134	25490	25,478	0.0003	0.5	243.4	0.000	0.107
0.1203	26789	26,140	0.0178	33.9	277.3	0.022	0.129
0.1269	27734	27,262	0.0177	33.8	311.2	0.023	0.152
0.1333	28361	28,048	0.0177	33.7	344.9	0.025	0.177
0.1395	28703	28,532	0.0174	33.3	378.2	0.027	0.204
0.1426	28777	28,740	0.0088	16.7	394.9	0.014	0.218
0.1433	28786	28,782	0.0020	3.8	398.7	0.003	0.222
0.1441	28791	28,789	0.0023	4.3	403.0	0.004	0.225
0.1445	28793	28,792	0.0011	2.2	405.2	0.002	0.227
0.1447	28793	28,793	0.0006	1.1	406.3	0.001	0.228
0.1448	28793	28,793	0.0003	0.5	406.8	0.000	0.229
0.1448	28793	28,793	0.0000	0.0	406.8	0.000	0.229
0.1449	28793	28,793	0.0003	0.5	407.4	0.000	0.229
0.1449	28793	28,793	0.0000	0.0	407.4	0.000	0.229
0.1510	28682	28,738	0.0173	33.0	440.3	0.031	0.260
0.1572	28370	28,526	0.0174	33.2	473.6	0.034	0.294
0.1634	27883	28,127	0.0172	32.8	506.3	0.036	0.331
0.1698	27244	27,564	0.0174	33.2	539.5	0.040	0.371
0.1763	26475	26,860	0.0172	32.8	572.3	0.043	0.414
0.1830	25597	26,036	0.0172	32.8	605.1	0.047	0.462
0.1899	24628	25,113	0.0171	32.6	637.7	0.051	0.513
0.1972	23586	24,107	0.0173	33.1	670.8	0.057	0.570
0.2047	22487	23,037	0.0170	32.5	703.3	0.062	0.632
0.2126	21346	21,917	0.0170	32.6	735.8	0.068	0.700
0.2210	20175	20,761	0.0172	32.8	768.6	0.076	0.776
0.2298	18988	19,582	0.0170	32.4	801.0	0.083	0.859
0.2393	17795	18,392	0.0172	32.8	833.8	0.093	0.952
0.2493	16607	17,201	0.0169	32.3	866.2	0.102	1.054
0.2601	15431	16,019	0.0170	32.5	898.7	0.114	1.169
0.2718	14276	14,854	0.0171	32.7	931.4	0.128	1.297
0.2843	13150	13,713	0.0169	32.2	963.6	0.142	1.439
0.2980	12057	12,604	0.0170	32.5	996.1	0.161	1.600
0.3130	11004	11,531	0.0170	32.5	1,028.6	0.182	1.783
0.3294	9994	10,499	0.0169	32.4	1,061.0	0.206	1.988
0.3476	9032	9,513	0.0170	32.5	1,093.5	0.235	2.224
0.3676	8119	8,576	0.0169	32.2	1,125.7	0.266	2.490
0.3900	7259	7,689	0.0170	32.4	1,158.1	0.307	2.797
0.4152	6452	6,856	0.0170	32.5	1,190.6	0.355	3.152
0.4435	5700	6,076	0.0169	32.3	1,222.9	0.410	3.562
0.4756	5003	5,352	0.0169	32.3	1,255.2	0.477	4.039
0.5124	4361	4,682	0.0170	32.4	1,287.6	0.561	4.600
0.5546	3774	4,068	0.0169	32.3	1,319.9	0.660	5.261
0.5662	3635	3,705	0.0042	8.1	1,328.0	0.184	5.445
	28,793 Max		0.695 Impulse	1,328 Bullet Vel.		5.445 Bullet Travel	

The impulse that acted on the bullet also acts on the breech face of the bolt, forcing the bolt rearward. We can use this type of analysis to find the recoil velocity of the bolt.

The first step in a rigorous investigation of the bolt recoil and counter recoil is to derive a number of important equations describing the motion of the bolt. These derivations are all based on the fact that as the bolt moves in recoil, the driving spring absorbs and stores energy. While this analysis starts with the approach of Lt. Colonel George Chinn in his book *The Machine Gun, Design Analysis of Automatic Firing Mechanisms and Related Components Volume IV, Parts X and X,* it considers the effects of friction, firing angle, and the effect of the bolt's impact at the rear of the receiver, whereas Chinn's analysis did not. As will be shown, these effects are considerable.

If we approach the problem based on a conservation of energy, then the energy remaining in the bolt at any time during its recoil stroke with the bolt moving to the rear is expressed by the following equation:[12]

$$\frac{MrVr^2}{2} = Er - \left(Fod + fd + \frac{Kd^2}{2}\right)$$

Where:			
	Mr	=	Mass of the recoiling components
	Vr	=	Velocity of the recoiling components
	Er	=	Initial energy available to do work
	Fo	=	Initial compressive force on the bolt from the action spring
	f	=	Retarding frictional forces
	K	=	Action spring's spring constant
	d	=	Distance the bolt has traveled

This equation may be used for deriving the equation expressing the relationship between time and the bolt's rearward motion. Solving for Vr, the velocity of the recoiling components, results in the following:

$$\frac{MrVr^2}{2} = Er - (Fo + f)d - \frac{Kd^2}{2}$$

$$Vr^2 = \frac{-K}{Mr}d^2 - \frac{2(Fo+f)}{Mr}d + \frac{2Er}{Mr}$$

$$Vr = \sqrt{\frac{-K}{Mr}d^2 - \frac{2(Fo+f)}{Mr}d + \frac{2Er}{Mr}}$$

Because velocity is equal to the change in distance divided by the change in time:

$$Vr = \frac{dd}{dt} = \sqrt{\frac{-K\,d^2}{Mr} - \frac{2(Fo+f)\,d}{Mr} + \frac{2Er}{Mr}}$$

$$dt = \frac{dd}{\sqrt{\frac{-K\,d^2}{Mr} - \frac{2(Fo+f)\,d}{Mr} + \frac{2Er}{Mr}}}$$

From a table of integrals, we find the following solution:

$$\frac{dd}{\sqrt{ad^2 + bd + c}} = \frac{1}{\sqrt{-a}} \sin^{-1} \frac{-2ad - b}{\sqrt{b^2 - 4ac}} + C$$

where:

$$a = \frac{-K}{Mr}$$

$$b = \frac{-2(Fo + f)}{Mr}$$

$$c = \frac{2Er}{Mr}$$

Therefore:

$$t = -\sqrt{\frac{Mr}{K}} \sin^{-1} \left[\frac{\frac{2K\,d}{Mr} + \frac{2(Fo + f)}{Mr}}{\sqrt{\frac{4(Fo + f)^2}{Mr^2} + \frac{8KEr}{Mr^2}}} \right] + C$$

$$t = -\sqrt{\frac{Mr}{K}} \sin^{-1} \left[\frac{\frac{2}{Mr}\,Kd + \frac{2}{Mr}\,(Fo + f)}{\frac{2}{Mr}\sqrt{Fo^2 + 2Fof + f^2 + 2KEr}} \right] + C$$

$$t = \sqrt{\frac{Mr}{K}}\, \sin^{-1}\left[\frac{Kd + Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + 2KEr}}\right] + C$$

If we assign the term $\sqrt{Fo^2 + 2Fof + f^2 + 2KEr}$ to be equal to Q

Then substituting this back into the expression for t gives the following:

$$t = \sqrt{\frac{Mr}{K}}\, \sin^{-1}\left[\frac{Kd + Fo + f}{Q}\right] + C$$

At $t = 0$, $d = 0$; therefore:

$$C = -\sqrt{\frac{Mr}{K}}\, \sin^{-1}\left[\frac{Fo + f}{Q}\right]$$ and this leaves us with:

$$\boxed{t = \sqrt{\frac{Mr}{K}}\left[\sin^{-1}\frac{Kd + Fo + f}{Q} - \sin^{-1}\frac{Fo + f}{Q}\right]}$$

This provides the formula for describing the movement of the recoiling components. Solving this equation for distance (d) as a function of time (t) yields the following:

$$\boxed{d = \frac{Q \sin\left[(t)\sqrt{\frac{K}{Mr}} + \sin^{-1}\frac{Fo + f}{Q}\right] - Fo - f}{K}}$$

Remembering that : $\sqrt{Fo^2 + 2Fof + f^2 + 2KEr} = Q$

We need to define Er as the initial energy available to push the bolt rearward, and this is equal to:

$$Er = \tfrac{1}{2} Mr\,(Vbolt)^2$$

We determine the velocity of free recoil as being equal to the area under the pressure-versus-time curve divided by the mass of the recoiling parts due to the following reasoning:

$$\begin{aligned} \text{Force} &= \text{Mass * Acceleration} \\ F_{pressure} &= \text{Mass * Velocity Bolt/Time} \\ \text{Vbolt} &= \text{Pressure(Bore Area)(t)/Mr} \\ \text{Vbolt} &= \text{Impulse/Mr} = I / Mr \end{aligned}$$

Then:

$$Er = \tfrac{1}{2} Mr\,(I / Mr)^2$$

$$Er = \tfrac{1}{2} I^2 / Mr$$

Substituting:

$$t = \sqrt{\frac{Mr}{K}} \left[\sin^{-1} \frac{Kd + Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + \frac{KI^2}{Mr}}} - \sin^{-1} \frac{Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + \frac{KI^2}{Mr}}} \right]$$

$$d = \frac{\sqrt{Fo^2 + 2Fof + f^2 + \frac{KI^2}{Mr}}\ \sin \left[(t)\sqrt{\frac{K}{Mr}} + \sin^{-1} \frac{Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + KI^2}} \right] - Fo - f}{K}$$

This same type of analytical procedure can be done to determine the equations for the motion of the bolt moving forward. Here the stored energy of the recoil or action spring drives the bolt forward, retarded by the friction forces. Again, from the conservation of energy standpoint, the following is true:

$$\frac{MrVf^2}{2} = \text{Energy Stored by the spring} - \text{Energy Expended} - \text{frictional losses} + \text{Rebound Energy from Bolt Impact}$$

$$\frac{MrVf^2}{2} = FoD + \frac{KD^2}{2} - \left[Fo(D-d) + \frac{K}{2}(D-d)^2 \right] - fd + \frac{MrVi^2}{2}$$

Where:

Mr	=	Mass of the bolt components
Vf	=	Velocity of the bolt components back into battery
Vi	=	Resultant velocity of the bolt impact with the receiver
e	=	Coefficient of restitution of the bolt impact
Fo	=	Initial compressive force on the bolt from the action spring
f	=	Retarding frictional forces
K	=	Action spring's spring constant
d	=	Distance the bolt has traveled
D	=	Total bolt travel in recoil

The coefficient of restitution, e, is a ratio that defines the difference between the impact velocity and the rebound velocity from the impact of one body with another. A coefficient of restitution of 1 implies a perfectly elastic collision, where the rebound velocity is equal to the impact velocity; no loss of velocity occurs. A coefficient of restitution of 0 implies that the impact force and velocity are totally absorbed by the impact of one body with another. This coefficient is not totally a material property; a part's geometry affects this number as well as how the collision takes place. Regardless, the coefficient is the ratio between the impact velocities of the bolt impact to its rebound velocity. Therefore:

$$e = Vi/Vr \qquad \text{or} \qquad Vr(e) = Vi$$

and then:

$$\frac{MrVf^2}{2} = FoD + \frac{KD^2}{2} - FoD + Fod - \frac{KD^2}{2} + KDd - \frac{Kd^2}{2} - fd + \frac{MrVr^2 e^2}{2}$$

$$\frac{MrVf^2}{2} = FoD + KDd - \frac{Kd^2}{2} - fd + \frac{MrVr^2 e^2}{2}$$

$$\frac{MrVf^2}{2} = -\frac{Kd^2}{2} + d(Fo + KD - f) + \frac{MrVr^2 e^2}{2}$$

Solving for Vf yields:

$$Vf = \sqrt{-\frac{Kd^2}{Mr} + \frac{2d}{Mr}(Fo+KD-f) + Vr^2 e^2}$$

$$dTt = \frac{dd}{\sqrt{\frac{-K}{Mr}d^2 + \frac{2d}{Mr}(Fo+KD - f) + Vr^2 e^2}}$$

$$dTt = \frac{dd}{\sqrt{\frac{2(Fo + KD - f)}{K} d - d^2 + \frac{Mr}{K}Vr^2 e^2}} \sqrt{\frac{Mr}{K}}$$

From a table of integrals:

$$\frac{dd}{\sqrt{-d^2 + 2ad + B}} = \tan^{-1}\left[\frac{(d-a)\sqrt{- d^2 + 2ad + B}}{d^2 + 2ad - B}\right] + C$$

Where:

$$a = \frac{Fo + KD - f}{K}$$

$$B = \frac{MrVr^2 e^2}{K}$$

$$Tt = \sqrt{\frac{Mr}{K}} \tan^{-1}\left[\frac{(d-a)\sqrt{-d^2 + 2ad + B}}{d^2 + 2ad - B}\right] + C$$

At $t = 0$, $d = 0$ so:

$$C = -\sqrt{\frac{Mr}{K}} \tan^{-1}\left[\frac{-a\sqrt{B}}{-B}\right]$$

This results in the following:

$$\boxed{Tt = \sqrt{\frac{Mr}{K}} \left[\tan^{-1}\left[\frac{(d-a)\sqrt{-d^2 + 2ad + B}}{d^2 + 2ad - B}\right] - \tan^{-1}\left[\frac{-a\sqrt{B}}{-B}\right]\right]}$$

The counter-recoil time is solved by replacing D for d to yield the following:

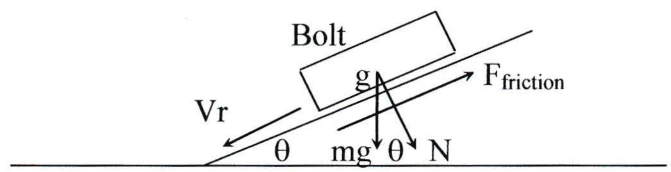
$$\boxed{Tt = \sqrt{\frac{Mr}{K}} \left[\tan^{-1}\left[\frac{(D-a)\sqrt{-D^2 + 2aD + B}}{D^2 + 2aD - B}\right] - \tan^{-1}\left[\frac{-a\sqrt{B}}{-B}\right]\right]}$$

Having done this portion of the analysis, we can now turn our attention to the frictional forces that are involved in retarding the bolt travel and define more clearly the (-f-) term in our calculations.

The first of these is the sliding friction that occurs between the bolt and the housing or receiver that houses the bolt assembly. This force acts over the entire distance the bolt moves and is a function of the particular elevation at which the firearm is fired; when the firearm is fired straight up at 90°, this retarding force is 0, and when the firearm is fired horizontally, this force is equal to the weight of the bolt assembly times the coefficient of friction. The relation that governs this type of behavior is as follows:

$$\text{Friction} = \sigma\,(Wr)(\cos\theta) \quad \text{where:}$$

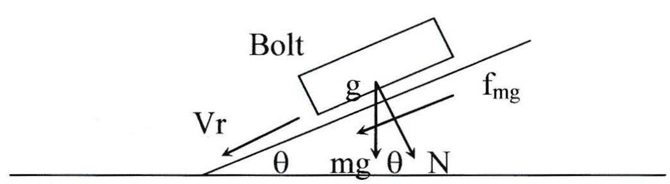
σ = Coefficient of friction
Wr = Recoiling components part weights
θ = Angle of elevation



$N/mg = \cos\theta$
$F = \sigma N$
$mg = Wr$

The second retarding force to be considered is gravity. Again, depending on the elevation, this force can affect the cyclic rate of the gun. When the barrel is pointed downward during the rearward motion of the bolt assembly, gravity will resist the motion, and when the barrel is pointed upward, it will aid recoil. While the gun is horizontal, this force is not present. The relation that covers this behavior is as follows:

$$f_{mg} = mg\sin\theta$$



$f_{mg}/mg = \sin\theta$
$f_{mg} = mg\sin\theta$
$f_{mg} = Wr\sin\theta$

Another frictional force to be overcome is that from the magazine box. This comes in two forms. The first is the force necessary to strip shells from the magazine box and feed them into the chamber. The second is the frictional force acting during counter recoil, where the next round to be fed presses upward on the bolt as it travels to the rear.

Generally, both of these forces can be ignored because the distance that they act over is short, the frictional coefficient is low, and, the force pressing up against the bolt, is partially negated by the weight of the bolt itself. Dividing the model into four discreet sections—two for recoil stroke and two for counter recoil—is also avoided by ignoring this effect. The force of the magazine spring is the largest variable for this frictional force.

Another variable in the cyclic rate is the shoulder of the shooter firing the weapon. Generally, smaller/lighter individuals do not control the gun when it is firing as well as large-stature/heavier individuals. This causes the gun to move to the rear more, and the relative velocity of the bolt to the receiver is reduced. This reduces the coefficient of restitution as well. In submachine guns, this effect is lessened in comparison with light machine guns due to the impulse of pistol cartridges being much less relative to the weight of the gun. For .22-caliber rifles, this effect is minimal. Testing is usually the best way to determine how the relative velocity condition will affect the gun's performance because it changes not only the bolt velocity but also the feeding dynamics of the cartridges. Allowing for "*heavy*" shoulder versus "*light*" shoulder shooters is a condition that all gun designers need to verify through extensive shooting tests. Most analyses that consider the shooter's shoulder attempt to model it as a spring-and-dash-pot system with different initial conditions for the two shoulder types. As shown later, good results are obtainable without taking this variable into account for this class of firearms.

Another variable not considered is recoil spring "*surge*". When the bolt starts to travel to the rear and after bolt impact with the receiver, the spring coils will generate a harmonic surge wave which reduces the effective load the spring exerts on the bolt. This dynamic condition was not considered in the analysis, but can be accounted for by lowering the coefficient of restitution selection to the value the designer feels is appropriate.

Finally, we come to the problem of case friction during the firing of the gun. Here, too, the frictional forces act for a very short period of time; the surface finish of the chamber is usually very good, which results in low coefficients of friction for the chamber; and the cases may have some oil on them as well, which lessens this bolt velocity effect. As a consequence, this variable was not included in the frictional force calculations. When the analysis of the Sten submachine gun was calculated using the equations previously presented, the following results were obtained for various firing angles:

Firing Angle (degrees)	**Coefficient of Restitution (e)**	**Calculated Recoil Time (sec)**	**Calculated Counter-Recoil Time (sec)**	**Calculated rpm Level**
90	.001	.0380	.0637	590
45	.001	.0376	.0632	595
0	.000	.0359	.0605	622
-45	.001	.0343	.0577	652
-90	.001	.0335	.0561	670

The full rpm calculation with the firing angle at 0 degrees and the coefficient of elasticity at .001 follows and yields an rpm level of 622.

Sten Gun Analysis Based on Derived Formulas and Assuming Frictional Drag and Elasticity

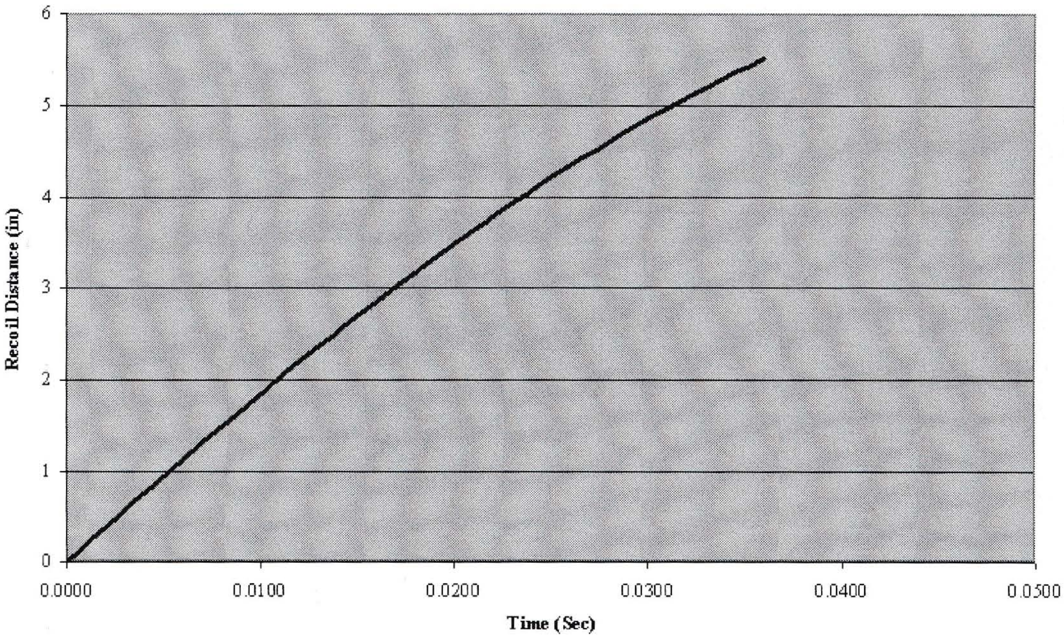
Variables		Input		Calculated		
		Values		Terms		
Bullet Weight (grains)	Wp	115		Weight of Recoiling Parts	Wt	1.40
Powder Charge Weight (grains)	Pc	6.0		Recoiling Mass	Mr	.0036
Impulse (lbs-sec)	I	.695		Er (in-lbs)	Er	66.7
Bolt Weight (lbs)	Wb	1.295		Q Term	Q	15.21
Extractor Weight (lbs)	We	.0156		a Term	a	7.85
Cocking Handle Weight (lbs)	Wc	.073		B Term	B	0.0
Spring Weight (lbs)	Ws	.047				
Full Bolt Stroke (in)	D	5.515				
Bolt Dynamic Friction Coefficient	σ	.25		Gravity Constant (lbs-sec^2/in)	G	386.4
Initial Spring Force on Bolt (lbs)	Fo	4.06				
Spring Constant (lbs/in)	K	1.589		Calc. Recoil Time (sec)	T	.0359
Firing Angle (degrees)	θ	0.0		Calc. Counter-Recoil Time (sec)	Tt	.0605
Elasticity Coefficient	E	.001		Calc. Rounds per Minute	rpm	622

Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
.0000	0	0.0	0	0	0	0	0	0	0
.0014	.3	0.0	.3	.275	191.0	.0113	.0113	.221	19.5
.0029	.3	0.0	.3	.547	-1.9	.01661	.0161	.441	46.6
.0043	.3	0.0	.3	.815	-2.1	.0197	.0198	.662	60.2
.0058	.3	0.0	.3	1.081	-2.3	.0228	.0229	.882	70.9
.0072	.3	0.0	.3	1.343	-2.4	.0256	.0256	1.103	79.9
.0086	.3	0.0	.3	1.602	-2.6	.0281	.0282	1.324	87.7
.0101	.3	0.0	.3	1.856	-2.8	.0304	.0305	1.544	94.7
.0115	.3	0.0	.3	2.106	-2.9	.0326	.0326	1.765	100.9
.0129	.3	0.0	.3	2.352	-3.1	.0347	.0347	1.985	106.6
.0144	.3	0.0	.3	2.593	-3.2	.0367	.0366	2.206	111.8
.0158	.3	0.0	.3	2.829	-3.4	.0385	.0385	2.427	116.6
.0173	.3	0.0	.3	3.061	-3.5	.0404	.0403	2.647	121.0
.0187	.3	0.0	.3	3.286	-3.7	.0421	.0420	2.868	125.1

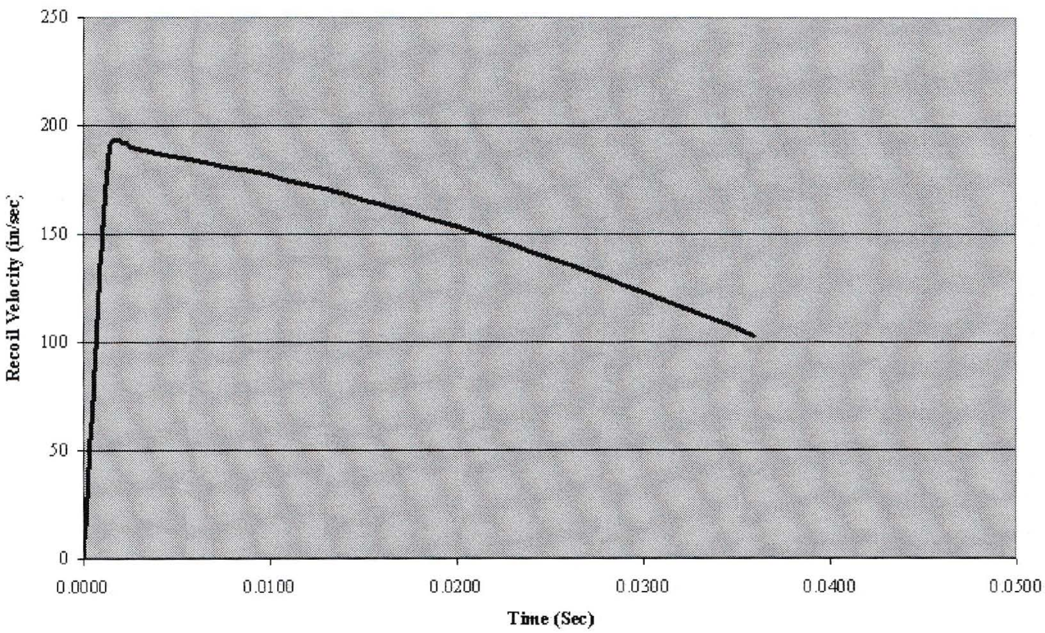
Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
.0201	.3	0.0	.3	3.507	-3.8	153.3	.0438	3.088	128.9
.0216	.3	0.0	.3	3.722	-4.0	149.3	.0455	3.309	132.4
.0230	.3	0.0	.3	3.930	-4.1	145.2	.0471	3.530	135.7
.0244	.3	0.0	.3	4.133	-4.2	141.0	.0487	3.750	138.8
.0259	.3	0.0	.3	4.330	-4.4	136.6	.0503	3.971	141.6
.0273	.3	0.0	.3	4.520	-4.5	132.1	.0518	4.191	144.2
.0288	.3	0.0	.3	4.703	-4.6	127.5	.0533	4.412	146.7
.0302	.3	0.0	.3	4.880	-4.7	122.8	.0548	4.633	148.9
.0316	.3	0.0	.3	5.049	-4.8	118.0	.0563	4.853	151.0
.0331	.3	0.0	.3	5.212	-4.9	113.1	.0577	5.074	152.9
.0345	.3	0.0	.3	5.367	-5.0	108.0	.0591	5.294	154.7
.0359	.3	0.0	.3	5.515	-5.1	102.9	.0605	5.515	156.2

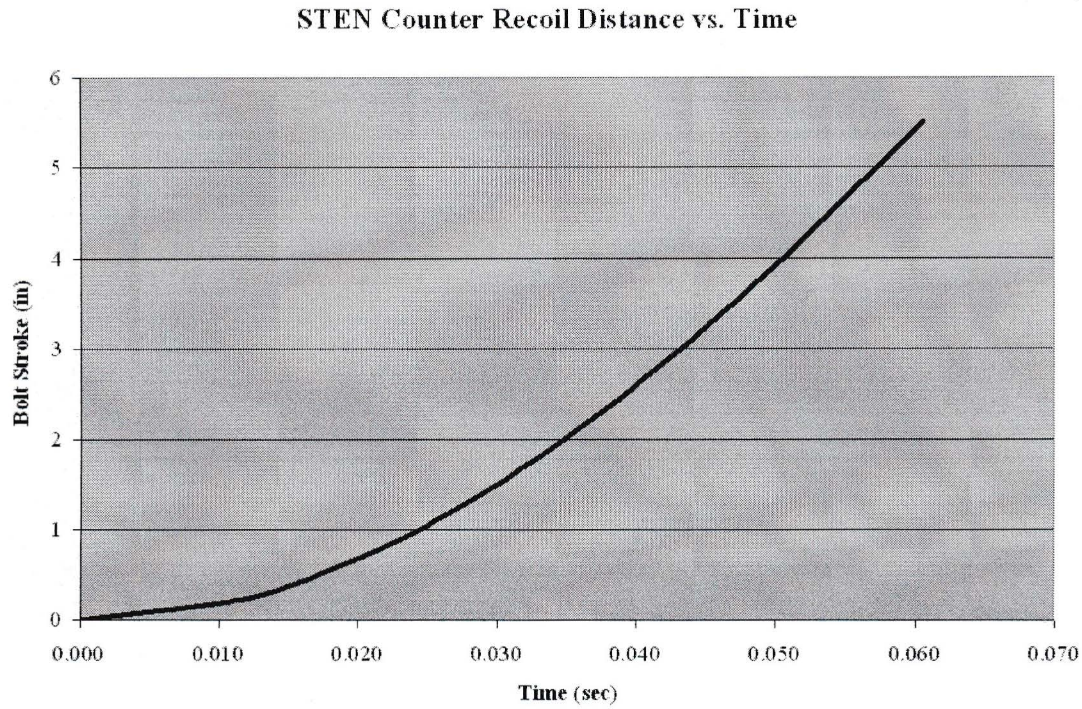
Total Calculated Recoil Time =	.0359
Total Calculated Counter-Recoil Time =	.0605
Calculated Rounds per Minute =	622

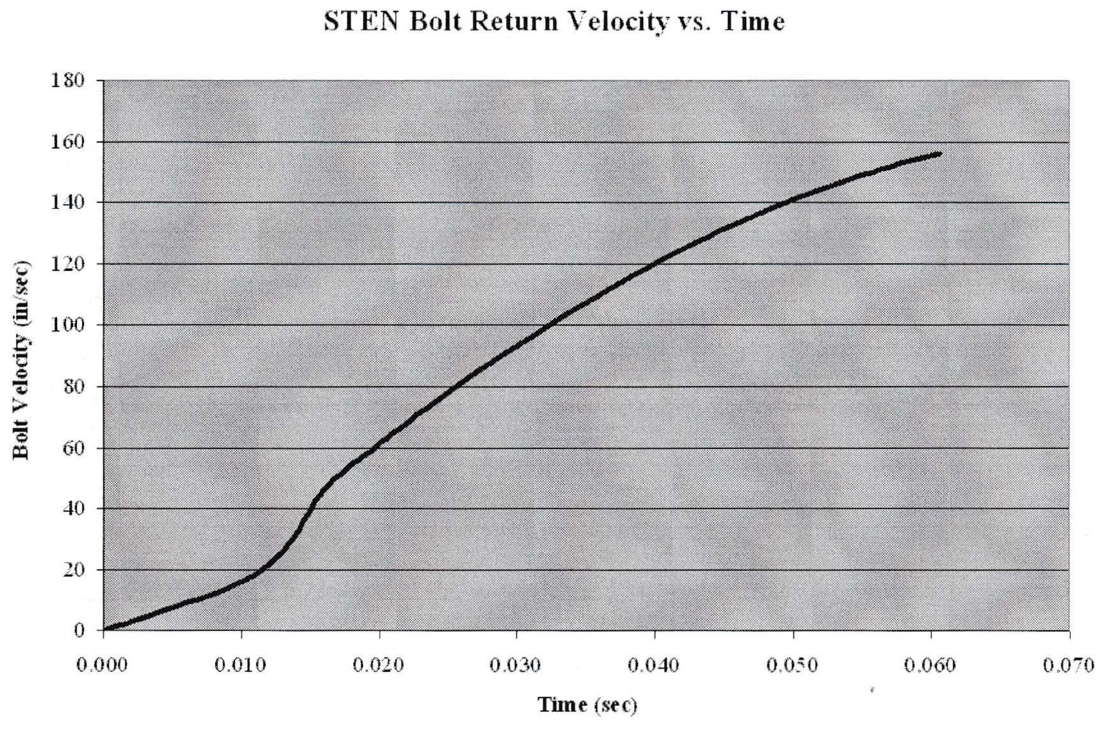
STEN Recoil Distance vs. Time



STEN Recoil Velocity vs. Time




STEN Counter Recoil Distance vs. Time
Bolt Stroke (in)
0
1
2
3
4
5
6
0.000
0.010
0.020
0.030
0.040
0.050
0.060
0.070
Time (sec)


STEN Bolt Return Velocity vs. Time
Bolt Velocity (in/sec)
0
20
40
60
80
100
120
140
160
180
0.000
0.010
0.020
0.030
0.040
0.050
0.060
0.070
Time (sec)

Varying the coefficient of restitution (e) within some believable limits affects the rpm figures but a restitution of .001 (essentially 0) yielded the best results of 622 rpm. This is due to the fact that the Sten does not incorporate a buffer component in its design. The analysis shows the bolt impacting the rear of the receiver at close to 100 in/sec. Examination of the parts kit that was used to reverse engineer the drawings showed that the stock face of the stock assembly was bent and that the spring cap inside the receiver had been impacted by the tail of the breech bolt which provides further confirmation that there is no rebound energy being provided to the bolt for its return stroke into battery. In the next chapter we will see confirmation of these rpm and velocity results using software from Working Model and an analysis of actual gun firing using WavePad software.

Appendix III shows how the reader can set up your own Excel spreadsheet to analyze and see the effect of certain parameters on the Sten's performance or to evaluate your own design once you have made inputs for the variables.

British Imperial War Museum
BU 2154
Men of the 15th Scottish Division leave their assault craft after crossing the Rhine and double up the east bank to their assembly point near Xanten.
March 24-31, 1945

Chapter 3
Technical Analysis
Considering Friction and Elasticity:
Working Model Simulation

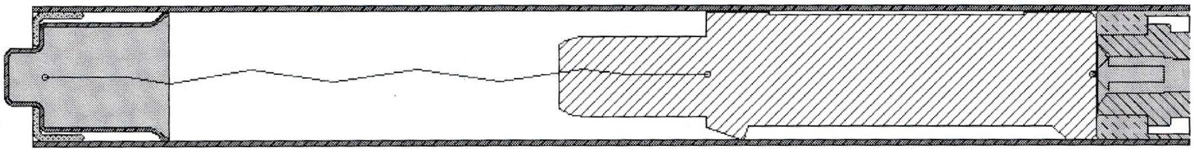
As demonstrated in my previous book on the Thompson Submachine gun, we can confirm the round per minute level presented in the previous chapter by using Working Model 2D software distributed by Design Simulation Technologies, Inc. This software allows engineers and designers to model problems such as a gun mechanism. With this type of model, we can both analyze the dynamic nature of the mechanism and also perform some "what if" type work by altering the inputs or pieces of the design.

For the purpose of this analysis, the force that was input to the bolt was the average impulse from the pressure-versus-time curve over its duration. While the program allows us to input the actual pressure (force)-versus-time curve of the round, using the average force is quicker and easier and does not affect the results. From the pressure-versus-time curve of the 115-grain, 9mm-caliber full metal jacket bullet presented earlier, we calculated that the total impulse supplied to the system was .695 lbs/sec. Therefore, the average force supplied by the round to the bolt rearward is equal to that impulse divided by the time it was applied, or:

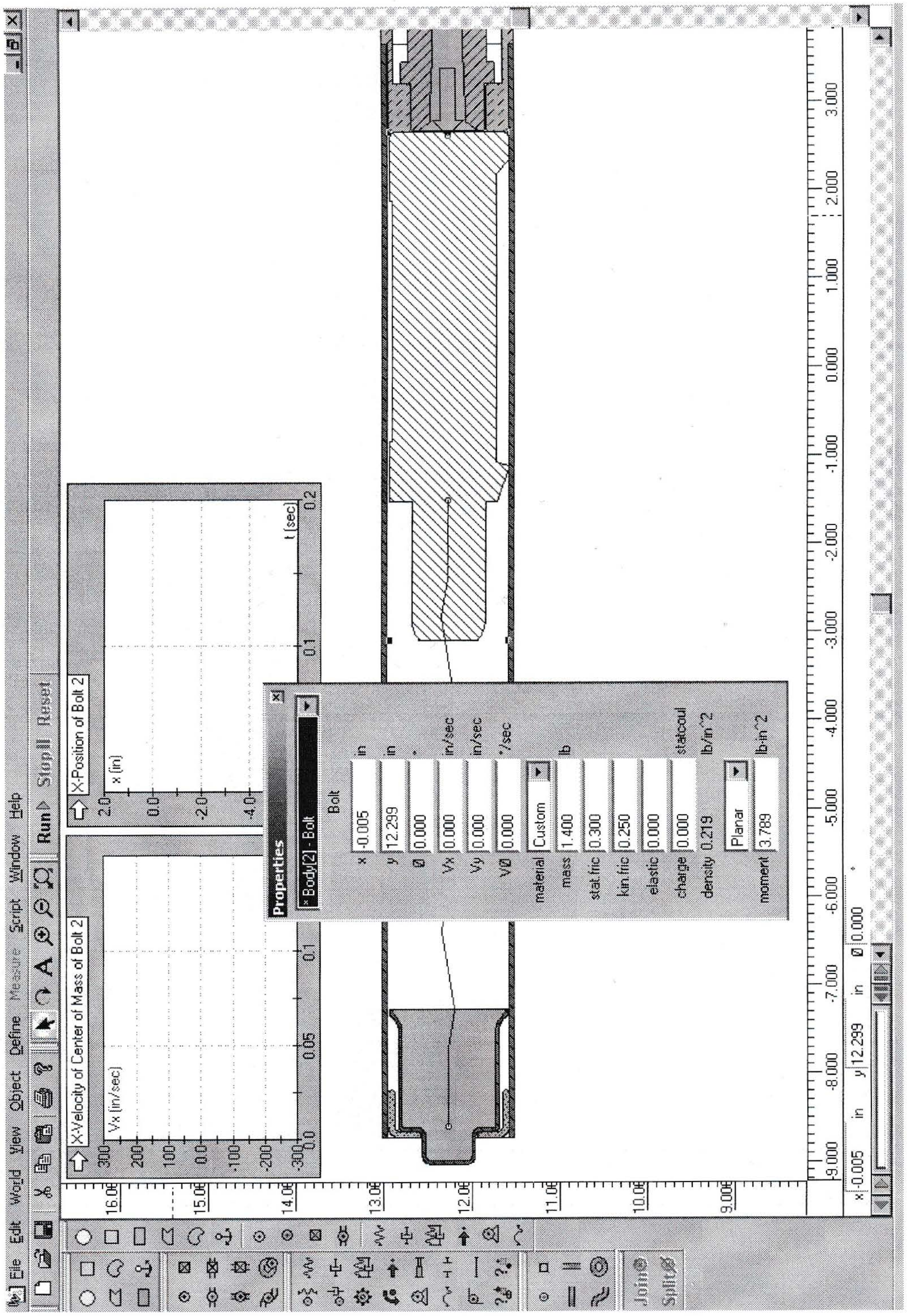
$$\frac{.695 \text{ lb/sec}}{.00566 \text{ sec}} = 122.8 \text{ lbs}$$

Below is the "Working Model" part file that depicts the Sten gun system in a simplified form. The receiver and bolt are modeled in a sectional representation. The bolt is allowed to slide between the receiver and the frame and can bounce between the top and bottom of the receiver; no slot joint is used.

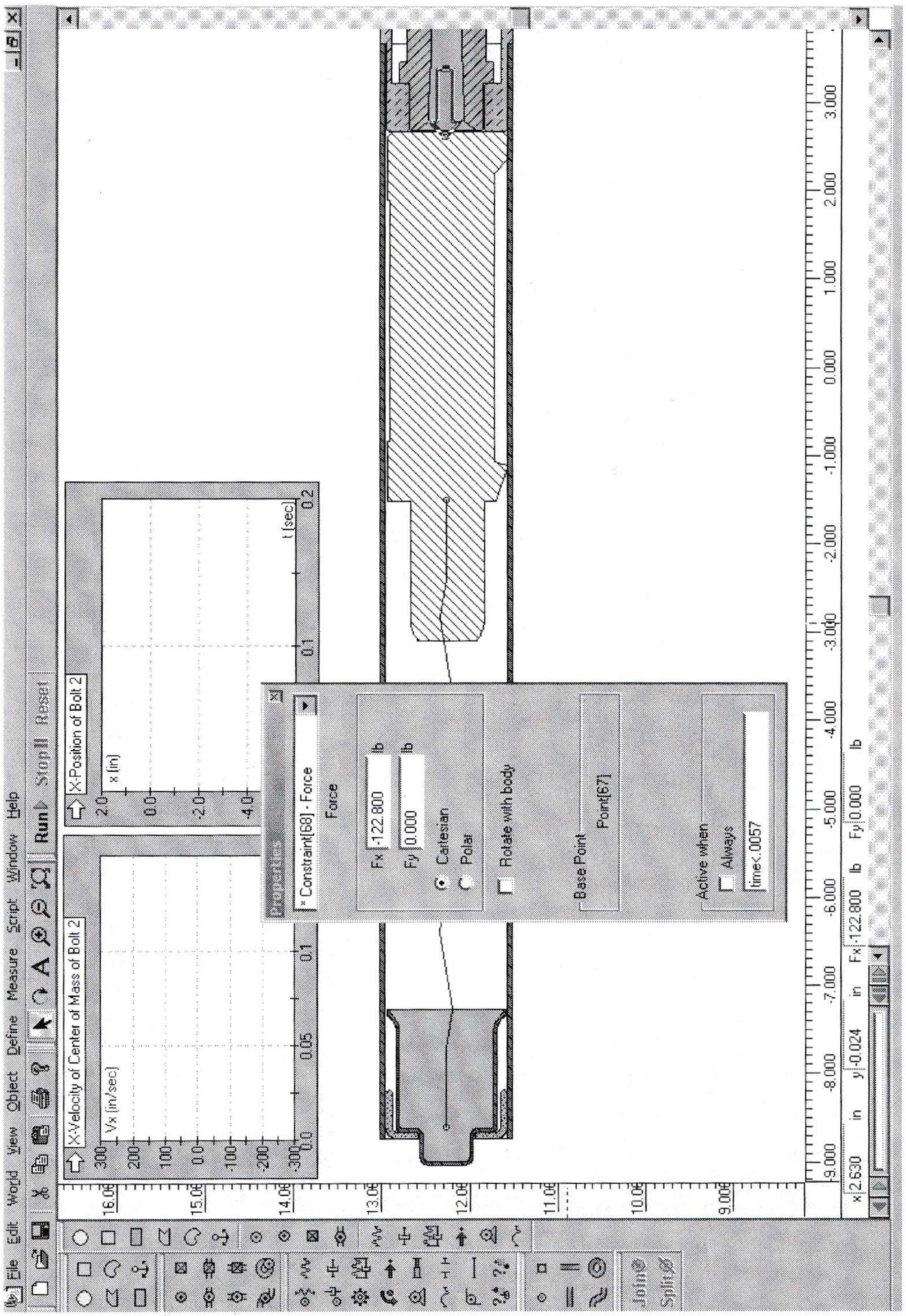
The bolt and all the components were given static friction values of .30 and dynamic friction values of .25. The bolt section's weight is input at 1.40 lbs and is the combination of the bolt, extractor, extractor spring, operating handle, and a third of the recoil spring weight.



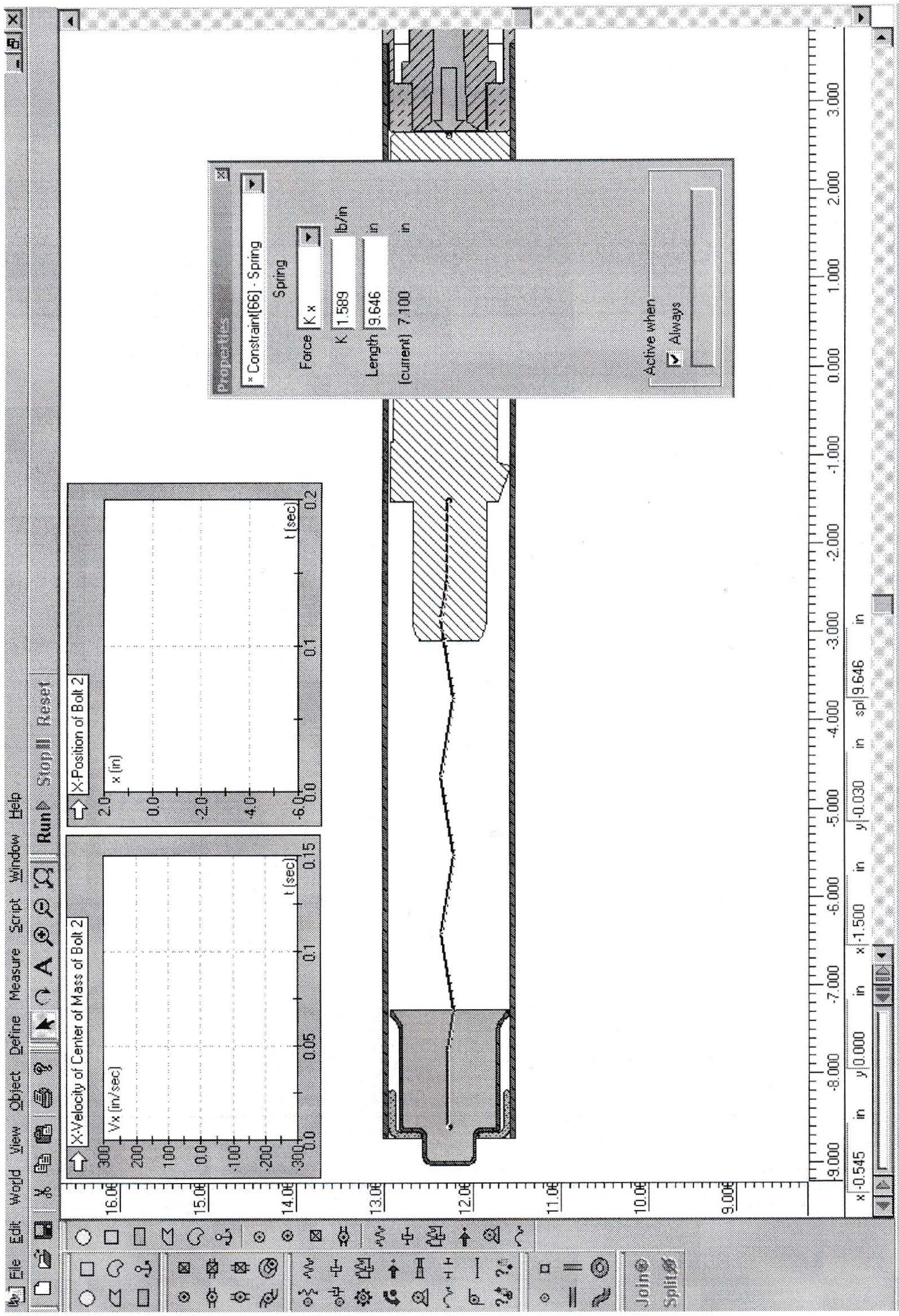
The bolt weight is set at 1.40 lbs. and the elasticity to .000 since there is no buffer. Good results were obtained using this value of elasticity.



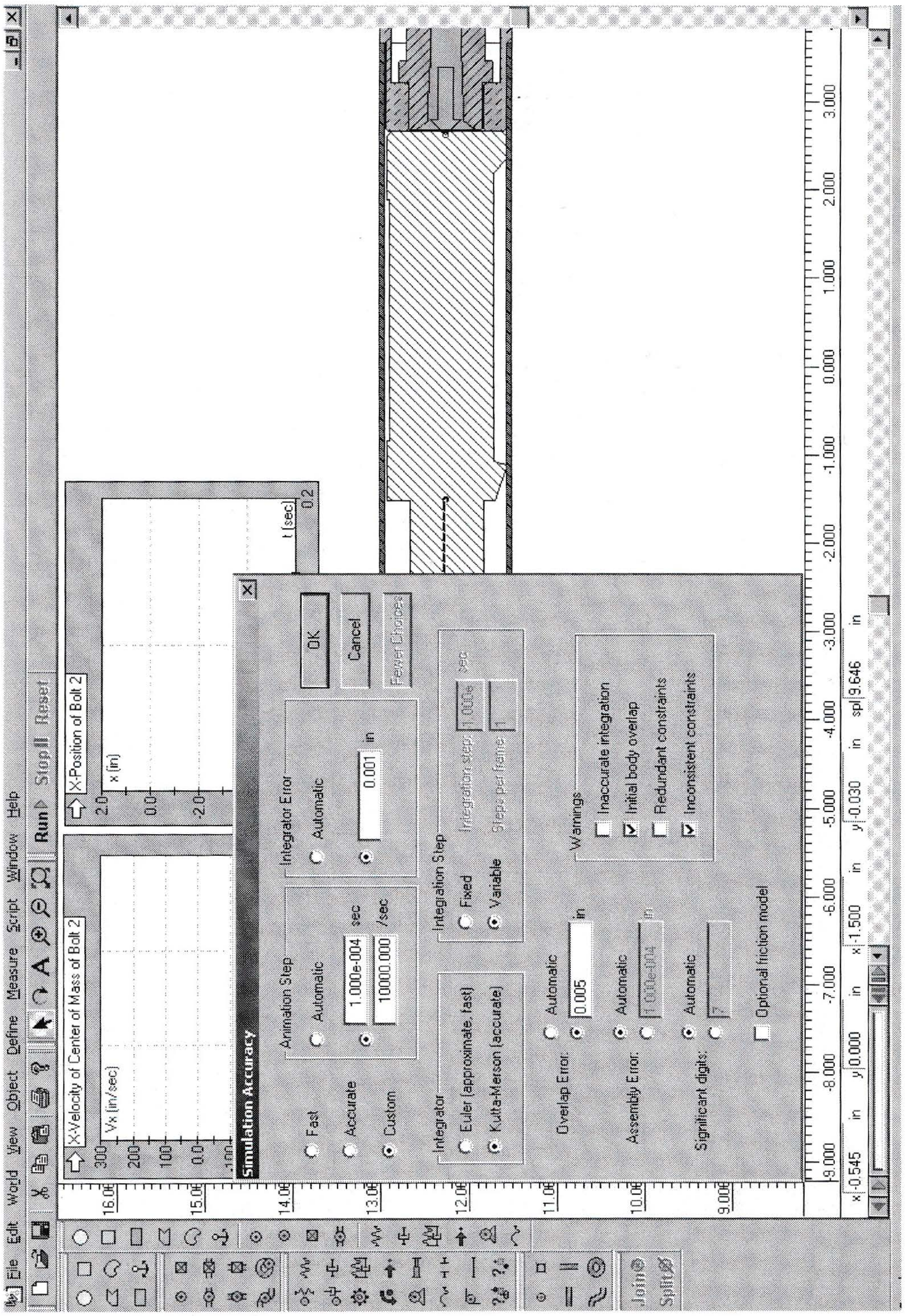
The force of 122.8 lbs is applied only for the first .0057 sec to achieve the impulse of .695 lbs/sec from the 9mm-caliber round.



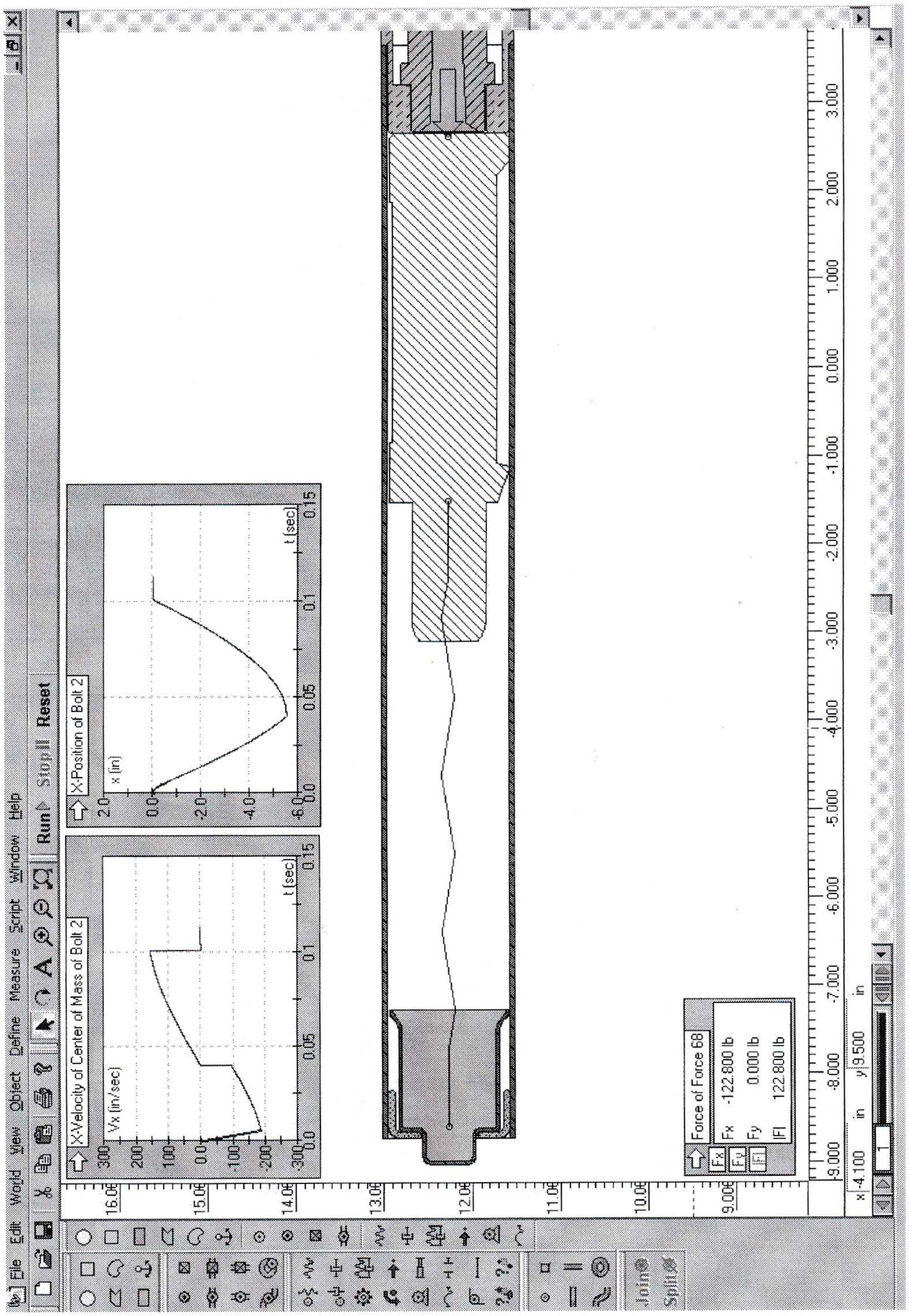
The action spring's spring rate of 1.589 lbs/in and free length's input of 9.646 inches are shown. The start length of the spring (L1) is 7.10 inches.



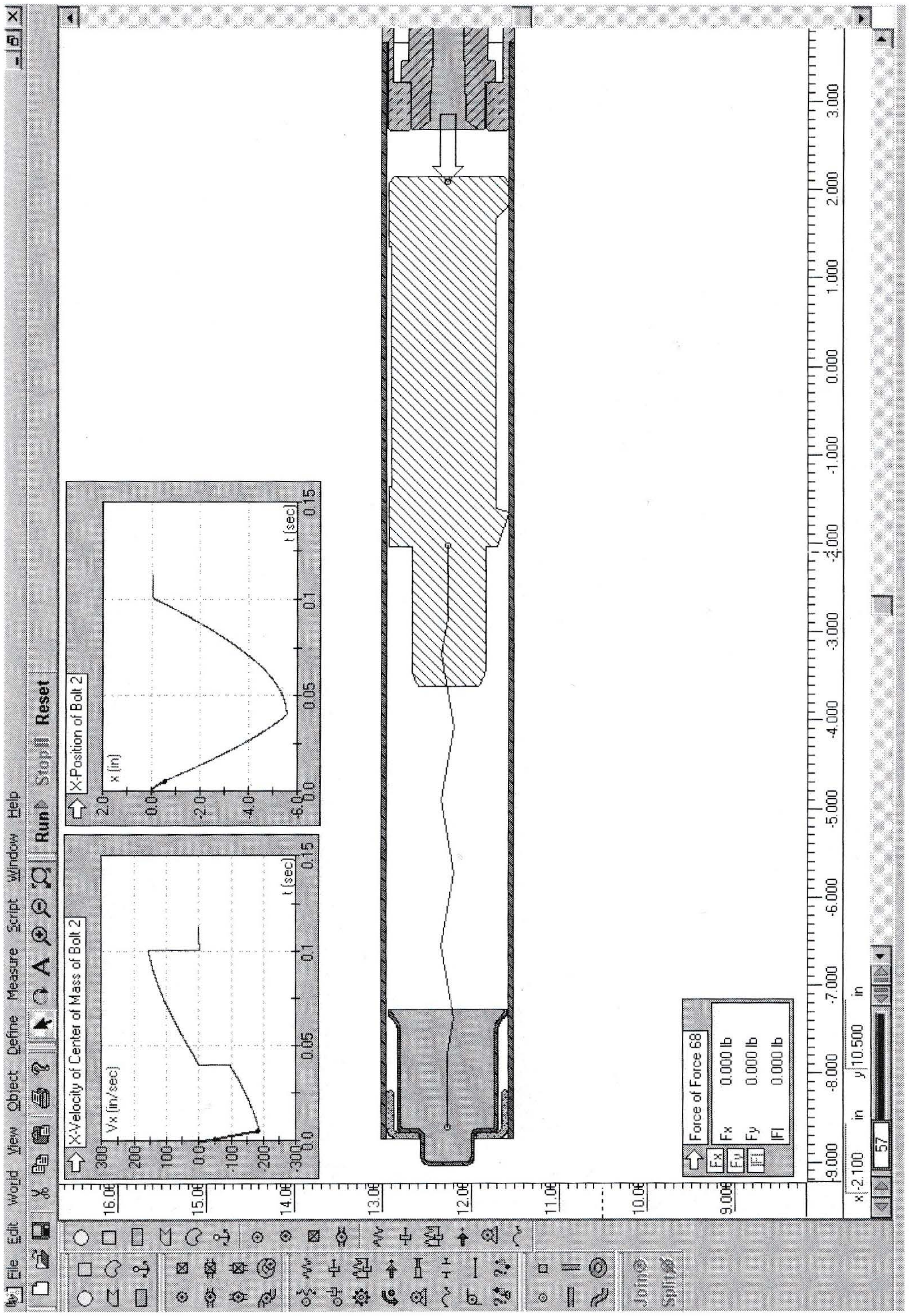
The time step used for the Sten's calculation of each frame was set to .00001 sec.



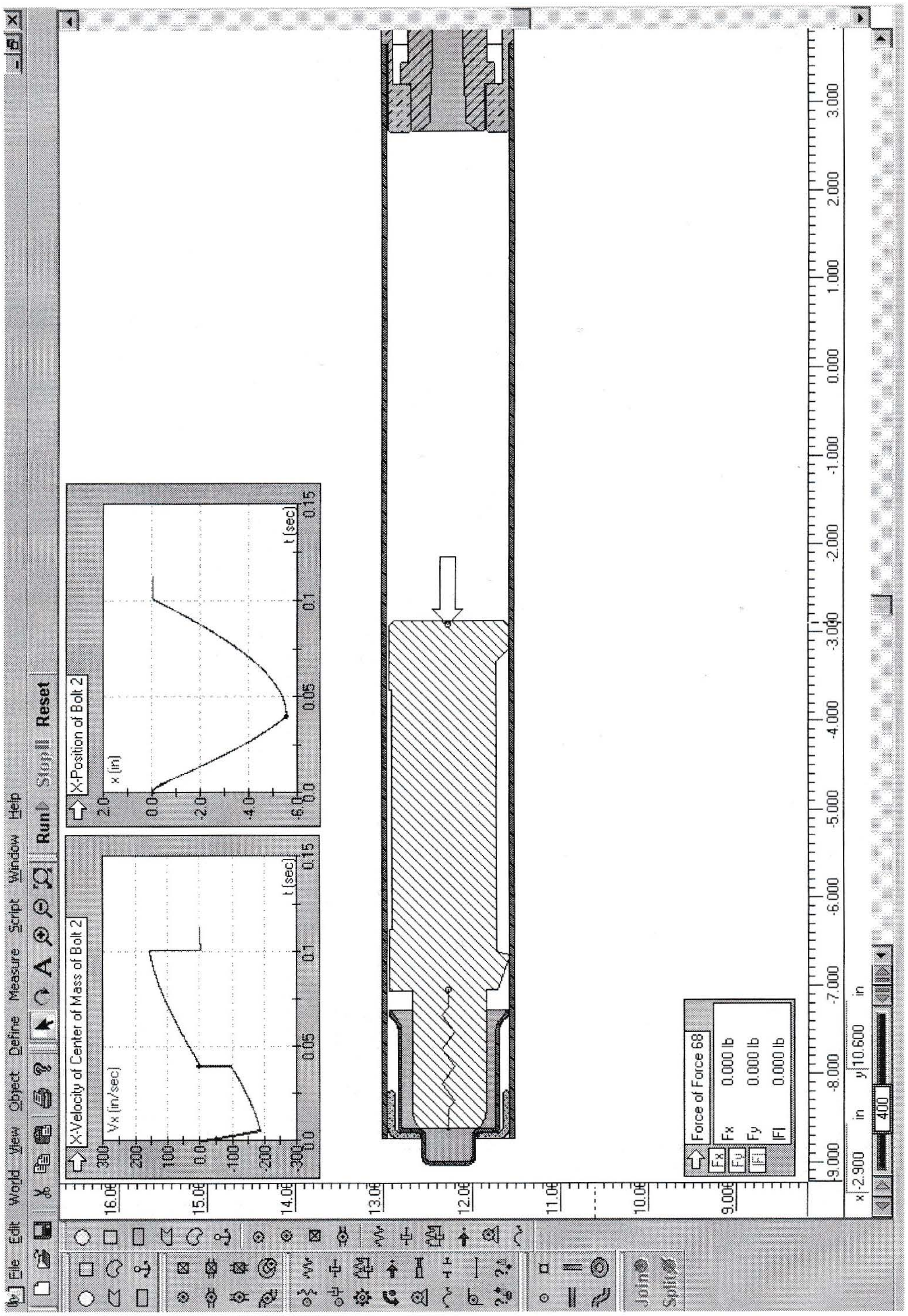
When the analysis was run, the following results were obtained:
At frame 1, the force has been applied to the bolt, and the bolt has started its movement to the rear.



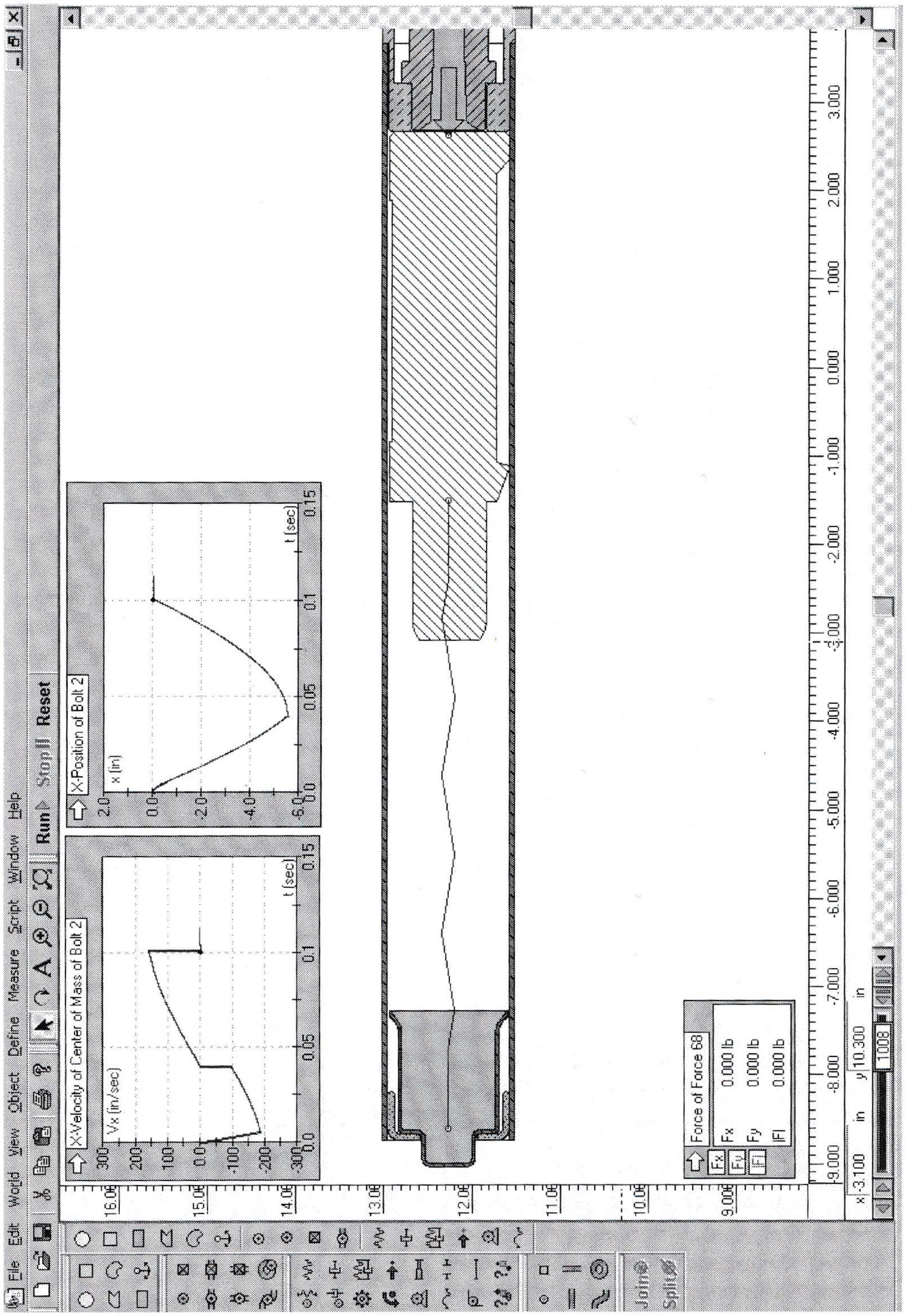
At frame 57 (.0057), the force is now off, as required.



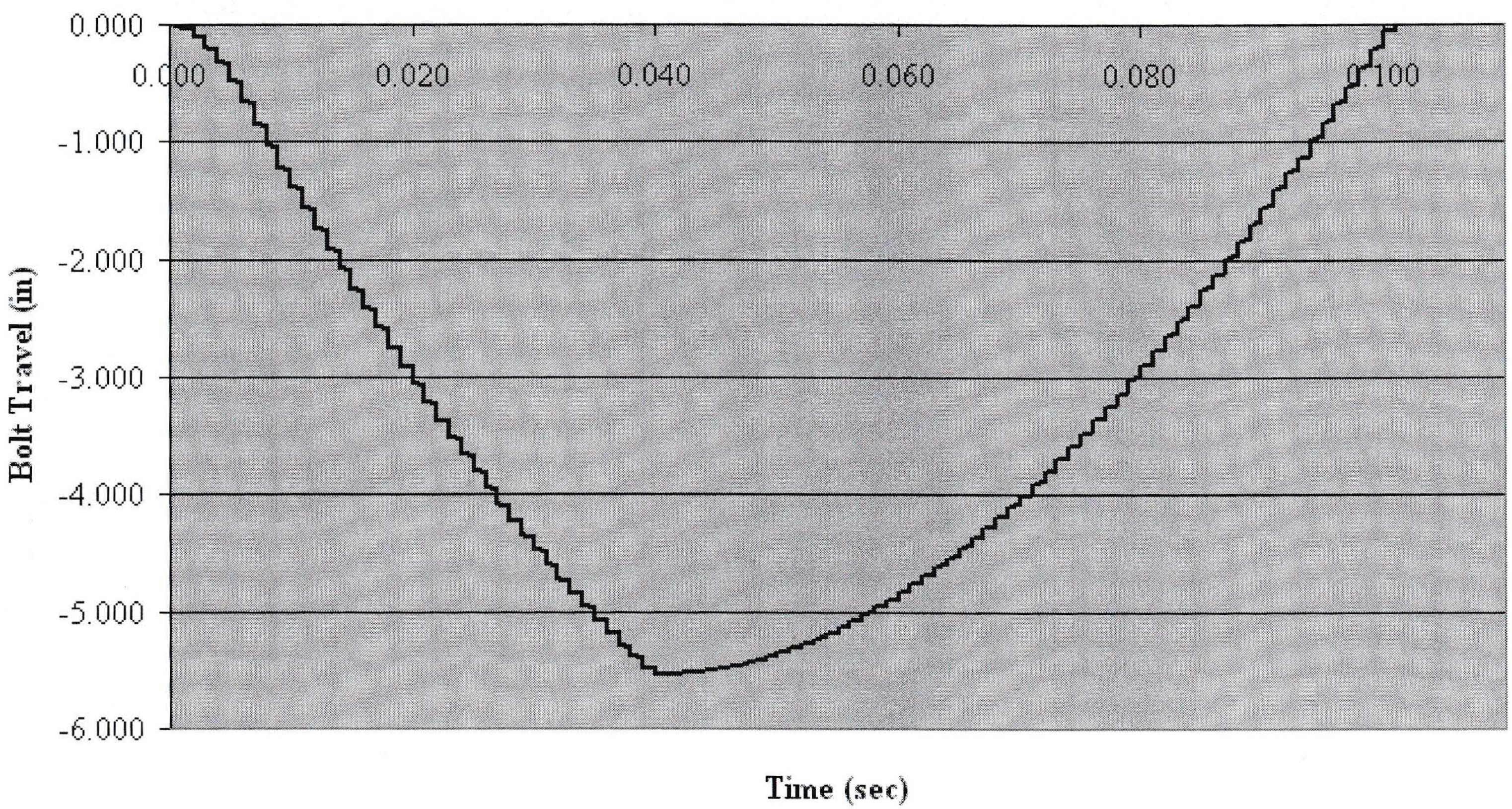
Frame 400 (.0400 sec) shows that the bolt has reached the rear of the receiver and has made impact with the buffer. The bolt reaches a maximum velocity of 190 in/sec and its velocity at impact is around 100 in/sec.



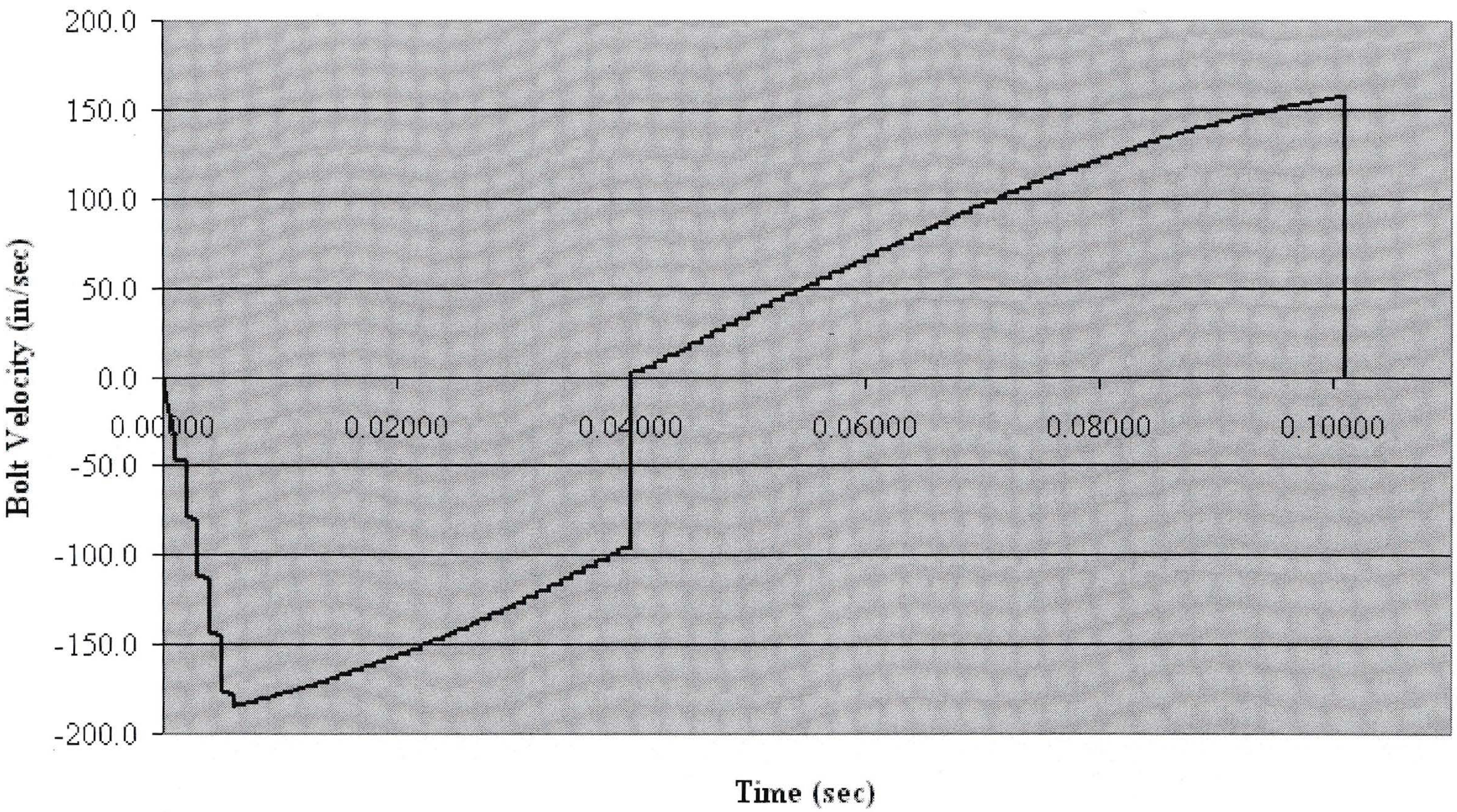
The bolt now is forced forward by the spring, returns to the front of the receiver at .1008 sec, and impacts at a velocity of 160 in/sec.



STEN Bolt Travel
Working Model Analysis
Elasticity = 0



STEN Bolt Velocity
Working Model Analysis
Elasticity = 0



A summary of both analysis techniques presented is shown below:

Analysis Type	Bolt Recoil Velocity @ Impact (in/sec)	Bolt Counter-Recoil Vel @ Impact (in/sec)	Recoil Stroke Time (sec)	Counter-Recoil Time (sec)	Total Stroke Time (sec)	rpm Level
Calculated Using Conservation of Energy - Includes Frictional Losses Elasticity = 0	102.9	156.2	.0359	.0605	.1009	622
Working Model Simulation - Includes Frictional Losses Elasticity = 0	94.4	156.9	.0406	.0603	.1014	592

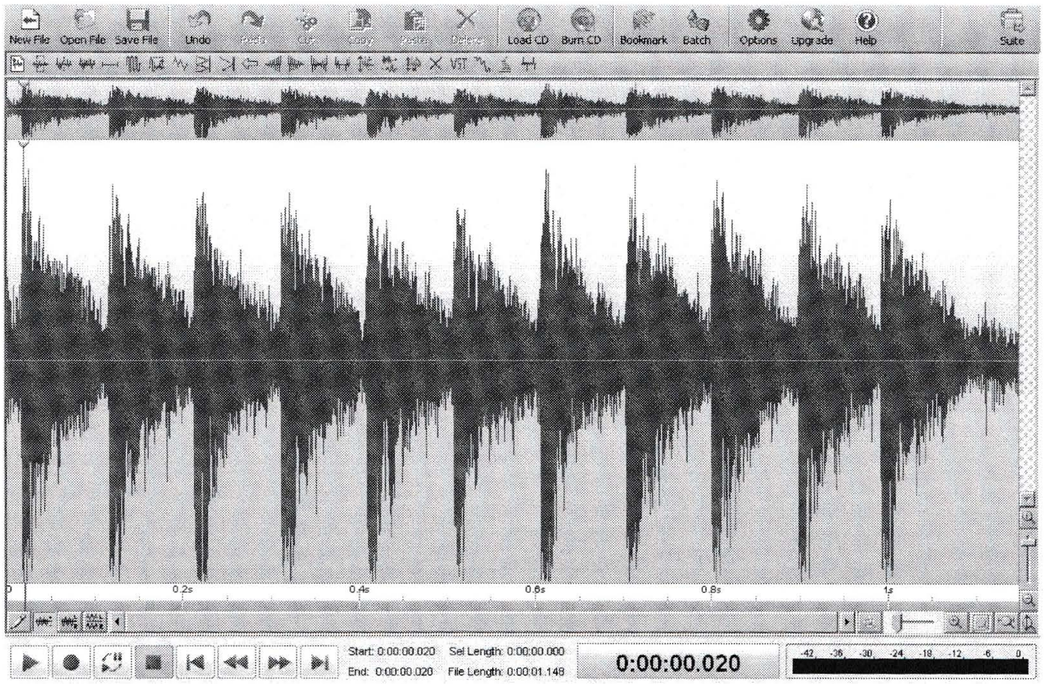
As there was with the Thompson M1A1 analysis, there is also very good correlation for the Sten between the two analyses that include frictional effects but how do they compare with actual published Sten rpm values and experimental results.

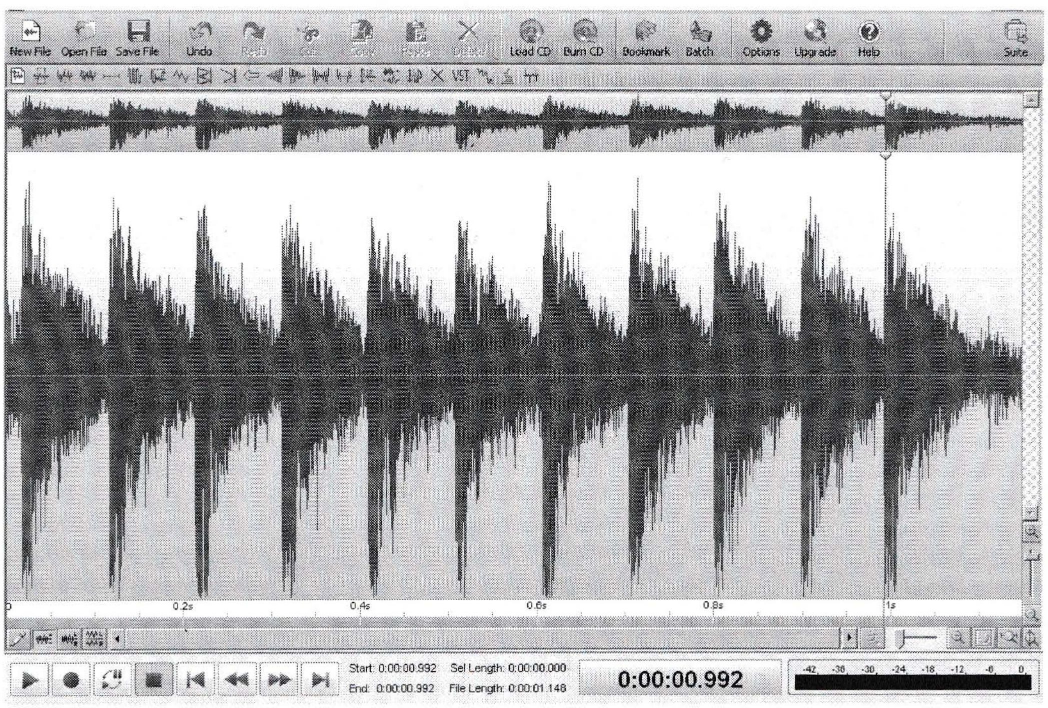
Reported Sten Round-per-Minute Values versus Calculated

rpm Value	Source of Information
550	Nelson, Thomas B., *The World's Submachine Guns*, T.B.N. Enterprises (1963), p.494
560	US Government, *First Report on Sten Sub-Machine Gun 9mm / MkII*, Ordnance Program 5082, Aberdeen Proving Ground (Jan. 6, 1942), p.11
622	Calculated Using Conservation of Energy and Includes Frictional Losses. Elasticity = 0
592	Working Model Simulation Using Impulse and Includes Frictional Losses. Elasticity = 0

The published results compare well but the calculated results are again higher as they were for the Thompson. A recording of a Sten firing full auto was obtained and analyzed using WavePad Sound Editor software. Firing start occurred at time .02 sec and ended at .992 sec. During this duration of .972 seconds, 10 rounds were fired. This yields an actual experimental rpm level of 617 rounds per minute and is within 5 % of the theoretical calculated results that include friction or the Working Model results. The analysis presented and given with current ammunition is therefore correct.

Full Auto Sten Test – Analysis using WavePad





.972 seconds	=	10 rounds fired		
972 / 10	=	60/rpm level		
rpm level	=	10* 60 / .972	=	617

DAPDCAP49005
Lt. Dan Guravich
Canada. Dept. of National Defence
Library and Archives Canada PA-163401
Infantrymen of Les Fusiliers Mont-Royal loading Sten gun magazines, Munderloh, Germany, April 29, 1945.

Chapter 4
Firearm Metallurgy and Heat Treatment

It is important that every gun designer have some knowledge of metallurgy and materials to be used in a gun design. Many of the large arms manufacturers employ a resident metallurgist to assist the design team in picking, not only the correct materials, but more importantly the right heat treatment for each application and to answer questions the design team has. This is an area where little knowledge can be dangerous but generally, most modern gun designs tend to overdesign in material strength and properties, so that the service live of the gun normally exceeds what the commercial shooter or even his children will see in their lifetime. Military users and law enforcement though can shoot to very high endurance round levels, and for these customers the best may still not be good enough.

Generally speaking, a gun designer usually cannot go wrong by specifying 4140 steel for many gun parts. 4140 steel has excellent strength properties as well as good ductility at Rockwell "-C-" hardness levels between 40 and 45. In addition, this is a material that can be both thru hardened as well as case hardened and so gives the designer more options to see if case hardening a part and leaving a soft inside core actually aids endurance life more than thru hardening a part that sees impact loading. It is also generally available. The downside is that alloy steel is more expensive than many other low-carbon steels that may be just as good. There are also materials that machine better but with today's equipment and cutting tools this is less an issue.

8620 steel can also be a good choice for many gun part applications where case hardening is desired. It can also be used for firing pins in the case hardened condition provided the case level is not so deep as to remove or eliminate the soft core in the part that is required to achieve longer endurance life than thru-hardened parts with little "-give-". 8620 was also the material used for the receivers of M/1 Garand, the M/14, and the bolt action Springfield 1903A3.

4140 steel will not be the best choice for gun stampings with small cross-sections and intricate bends that are hard to form. In this case, a material that is softer and easier to bend such as 1010, 1020, or 1025 may be the better choice and in some cases the only choice. Some steel stampings, especially "-W-" magazine springs commonly used for bolt-action rifle magazines, need to be made out of spring steel like 1070 and also require special fixturing to go through heat treat so the parts will not distort.

6150 steel can be a lifeline to a gun designer who has put himself in a box. This material has better tensile strength characteristics than many other spring steels and in some very high-stress situations is the only material that can give satisfactory endurance life. It is difficult to come by and expensive but in some cases can provide a solution where 1070 or 1095 spring steel will not work. Maraging stainless steels are required for very demanding endurance requirements where parts see high stress and impact. These materials can be used for shotgun choke tubes, extractors, and breech bolts but are expensive, are difficult to come by, and can be difficult to machine.

Stainless steel in general has been used more and more in gun design over the past couple of decades. This is due not only to customer preference and the desire for better corrosion resistance than carbon steel, but also to improvements in machine tool technology and tool design that make it less costly to machine than before. Cutting tools now may include carbide inserts or ceramic inserts that cut stainless steel very easily. For some process engineers, there is almost a preference for machining stainless rather than high alloy carbon steels and this was not true decades ago.

Generally, most compression or torsion springs for guns are made from music wire or 17-7 PH stainless steel wire. Music wire has better tensile strength whereas the stainless has better corrosion resistant properties without giving up too much in tensile strength. The stainless material is best for military and law enforcement applications if it can be used in the space provided. The high loads required, as well as the small space limitations, almost always mean the gun designer must have a good knowledge of spring design in order to have a robust gun design.

Metal injection molded (MIM) parts are being used more and more in modern gun design. MIM components are viewed by some consumers as not being as good as wrought steel. This is not the case. A well-designed, correctly heat-treated MIM part will have an endurance life as long as a wrought steel component with a better surface finish. For many components, it is the only economical way to make a part within the price point the customer can accept. It also provides more latitude in what a designer can conceive and design.

Powder metal (PM) parts provide an economic solution to many gun parts, including sears, hammers, and triggers as well as less stressed parts such as sights or pump shotgun guide rings. Powder metal may be used where the part has a flatter, more two-dimensional contour than it has different depths and complicated stepped contours, which is where MIM parts have the advantage in terms of manufacturability.

Lastly, investment cast parts are used for some gun parts but this is occurring less as MIM parts replace them or they are machined from bar stock. This process is being used less as customers become more comfortable with MIM or even plastic components that reduce the gun cost over investment cast parts. Investment cast firearm parts usually require secondary operations and polishing that may reveal porosity in the part making it difficult or impossible to repair causing scrap and higher costs.

Provided on the next several pages are tables that give commonly used gun materials and the treats for different types of components. These tables are a guide to materials commonly used in industry but it is not all encompassing. Testing always determines whether the designer has made the correct choice for material and heat treatment. In the case of the Sten, one of the design requirements was to use materials that were available and not in short supply like many of the alloy steels required for other high-value wartime weapons and materiel. While my drawings currently call for 4140 for the barrel and the breech bolt (since we are not at war), I believe a barrel from 1140 or a bolt made from 1118 steel and case hardened to HR15N 88 – 92 with a .008" thick case probably would have worked just fine as the barrel design chapter will show.

Firearm Material Selector & Heat Treatment

Carbon Steel (AISI)	Heat Treat	Hardness	Finish	Application
1010	Thru Carburize .50% Carbon Potential	HRC 42-46	Black Oxide	Thin progressive stampings with complicated geometry that see wear but not impact
1010 – 1020	Carburize .80% Carbon Potential	HR15N 88-92 (.008 Min Case)	Black Oxide	Machined or stamped components that see wear or contact
1022	Carburize .80% Carbon Potential	HR15N 85 Min. (.008 - .012 Case) Core HRC 28 - 38	Black Oxide	Machined or stamped components that see wear or contact
1118	Carburize .70% Carbon Potential	HRC 25 Min. HR15N 88 – 92 (.008 Min Case)	Black Oxide	Machined or stamped components that see wear or contact
1215	Carburize .75% Carbon Potential	HR15N 88 – 92	Black Oxide	Small turned parts like spring plungers
1035	Harden & Temper	HR 45N 41 – 49	Black Oxide	Firing pin, just the tip is hardened using induction hardening
1040 - 1050	Austemper	HRC 40 – 45	Black Oxide	Machined parts that see wear or contact that may distort due to heat treat
1070	Neutral Salt Harden	HRC 40 - 45	Black Oxide	Stampings like action bars or latches that see wear, contact, and some impact. Flat springs
1095	Neutral Salt Harden	HRC 48 – 53	Black Oxide	1095 is drill rod material and is used for turned parts like pins and high stressed flat springs

Note: Hardness testing method whether RC, RA, 15N is determined by the thickness of the material and heat treat method.

Firearm Material Selector & Heat Treatment

Alloy Steel (AISI)	Heat Treat	Hardness	Finish	Application
4137	Neutral Salt & Austemper	HRC 41 – 47	Black Oxide	Machined or stamped components that see wear or contact
4137	Harden & Temper	HRC 41 – 47	Black Oxide	Machined or stamped components that see wear or contact
4140	Harden & Temper	HRC 40 – 45	Black Oxide	Machined or stamped components that see wear or contact
4140	Harden & Temper	HRC 26 – 32	Black Oxide	Machined or stamped components that see wear or contact and especially barrels
4140	Austemper	HRC 40 – 45	Black Oxide	Machined parts that see wear or contact that may distort due to heat treat
4140	Carburize .75% Carbon Potential	HR15N 88-92 (.008 Min Case)	Black Oxide	Machined parts that see wear or contact that need a soft core to resist shock
6150	Austemper	HRA 74-78 HR15N 64-69	Black Oxide	Excellent material for flat springs seeing high stress
8620	Carburize .65% Carbon Potential	HR15N 88 – 92 (.006 Min Case)	Black Oxide	Firing pins that need a hard outer skin but soft core for shock.

Firearm Material Selector & Heat Treatment

Stainless Steel (AISI)	Heat Treat	Hardness	Finish	Application
416	Harden & Temper	HRC 26 – 32	Passivate Bright	Machined components and especially barrels
416	Vacuum Quench and Temper	HRA 69 – 72 (HRC 36 – 42)	Passivate Bright	Turned parts and especially threaded screws
440A or 440F	Vacuum Quench and Temper	HRC 50 - 55	Passivate Bright	Turned parts like pivot pins or threaded screws

Spring Material Selector & Heat Treatment

Spring Steel	Heat Treat	Hardness	Finish	Application
Music Wire ASTM-A228	Stress Relieve	N/A	Oil	Compression and extension springs
Music Wire ASTM-A228	Not Required	N/A	Oil	Torsion springs
17-7 PH Stainless Steel	Stress Relieve	N/A	Passivate	Compression and extension springs
17-7 PH Stainless Steel	Not Required	N/A	Passivate	Torsion springs

Metal Injection Molded (MIM) Material Selector & Heat Treatment

MIM	Heat Treat	Hardness	Finish	Application
MIM 4140	Same as AISI 4140	Same as AISI 4140	Same as AISI 4140	Same as AISI 4140
MIM 4605	Same as AISI 4140	Same as AISI 4140	Same as AISI 4140	Same as AISI 4140
MIM 2200	Carburize .80% Carbon Potential	HR15N 88-92 (.008 Min Case)	Black Oxide	Components that see wear or contact. Similar to AISI 1010 – 1020 and Iron 2% Nickel material
MIM 17-4 Stainless	H-900	HRC 38 – 45		Components that see wear or contact.
MIM 410 Stainless	H-900	HRC 38 – 45		Components that see wear or contact. Corrosion resistance not as good as 17-4

Powder Metal Material Selector & Heat Treatment

PM	Heat Treat	Hardness	Finish	Application
MPIF FN-0208 6.8 gr/cc^3 min density	Harden & Temper	HRC 40 – 45	Black Oxide	Components that see wear or contact
MPIF FC-0208 6.8 gr/cc^3 min density	Harden & Temper	HR15N 72 - 82	Black Oxide	Case hardened parts that see wear or contact.
MPIF FLN4-4405 6.8 gr/cc^3 min density	Harden & Temper	HRC 40 – 45	Black Oxide	Components that see wear, contact, or impact. Expensive material relative to the others.

Plastic Material Selector

PM	Type	Finish	Application
Polypropylene (PP) 20% Glass	Thermoplastic	Black	Stocks
LNP Verton (PA) Polyamide 50% Glass	Thermoplastic	Black	Firecontrol Housing or Trigger Plate
Delrin 100 (acetel)	Thermoplastic	Black	Magazine Followers
Nylon 6/6 (PA) Polyamide 30% Glass	Thermoplastic	Black	Gun Grips

Finishing of carbon steel firearm components is usually a black oxide finish or manganese phosphate finish to turn these metal components a black color. This is the low cost alternative for rust prevention and is used with oil to prevent corrosion. Powder metal parts require special finishing to help them retain their black oxide color; otherwise, the parts turn purple over time. Impregnation of the parts with a polymer resin to fill in the pores of the component is done before color. Stainless steel parts need to be passivated to aid their corrosion resistance after being machined with carbon steel cutters. Stainless steel parts can also be made black using a nitro-carburizing case hardening process referred to as "quench – polish – quench (QPQ). This process not only makes stainless steel black but also places an extremely hard surface layer on a part with no additional thickness to the part. QPQ is a thermo-chemical process that diffuses nitrogen and carbon into the surface of a steel part. This improves a part's wear resistance and lubricity. It is much more costly than black oxide. While it is used on stainless parts, it also can be used on carbon steel parts as well.

Finishing of aluminum parts with a black finish is accomplished using an anodizing process or by using a powder coat process. Type II anodizing adds .0005 to 001" thickness to the part. Hard coat anodizing adds .002 - .003". Powder coating adds .002 - .003" as well, so parts treated with these processes can have assembly problems if this added thickness is not accounted for by the designer.

National Film Board of Canada
Nicholas Morant
May 26, 1942
Woman worker poses with finished Sten Submachine Gun,
Small Arms Plant, Long Branch, Ontario, Canada.

Chapter 5
Barrel Design

You would think that barrel design should be a major concern for a commercial gun designer. Usually it is not. There are plenty of examples of successful competitive or past designs that reverse engineering a proven design, and using alloy steel with a mild heat treat (read 4140 @ HRC 26–32) is usually successful and safe, whether you look at a special high-pressure overstress test round with bullets lodged in the bore ahead of the chamber, a midbore obstruction test, or a lodged bullet at the muzzle for an additional obstruction test. Military full-automatic gun barrels experience an additional thermal stress test for the high temperature levels the barrel can experience that weaken the tensile strength of the steel.

You would also think that this is an area well covered by engineering analysis. The gun series *US Army Material Command Pamphlet AMCP 706-252 Gun Series - Gun Tubes* provides some guidance, and the following appears from its pages.[13] It offers barrel-design stress analysis for various gun-tube applications from standard barrels to recoilless gun barrels and barrels with liners (two-piece construction).

Commercial gun barrels are subject to three principal stresses. Military barrels experience these pressure induced stress components, which may be considered alone or combined with either or both the thermal or liner shrinkage stresses, depending on their requirements. These are the three main commercial barrel principal stresses:

σ_t = Tangential stress

σ_r = Radial stress

σ_a = Axial stress

These stress components are then inserted in the Von Mises-Hencky equation following the strain energy theory of failure to find an equivalent stress, σ_e.

$$2\sigma_e^2 = (\sigma_t - \sigma_r)^2 + (\sigma_r - \sigma_a)^2 + (\sigma_a - \sigma_t)^2$$

The stressed material remains in the elastic range as long as σ_e does not exceed the yield strength in tension. For an open-end cylinder, such as a gun barrel, the axial stress becomes zero and the equation reduces to:

$$\sigma_e^2 = \sigma_t^2 - \sigma_t\sigma_r + \sigma_r^2$$

According to Lame, the tangential stress (σ_t) at any diameter due to the pressure in the barrel (p) is:

$$\sigma_t = \frac{p\,D_i^2\,(D_o^2 + D^2)}{D^2\,(D_o^2 - D_i^2)}$$

where: D_i = Inside diameter
D_o = Outside diameter
D = Diameter at any point from D_i to D_o

For stress calculations, the rifling groove diameter is generally considered to be the inside diameter. The maximum tangential stress occurs at the inner wall diameter and this reduces the equation to:

$$\sigma_t = \frac{p\,W^2 + 1}{W^2 - 1}$$

where: $W = \frac{D_o}{D_i}$ (the wall ratio)

The general radial stress equation is:

$$\sigma_r = \frac{p\,D_i^2\,(D_o^2 - D^2)}{D^2\,(D_o^2 - D_i^2)}$$

The maximum radial stress again occurs on the inner wall, which reduces the equation to:

$$\sigma_r = -p$$

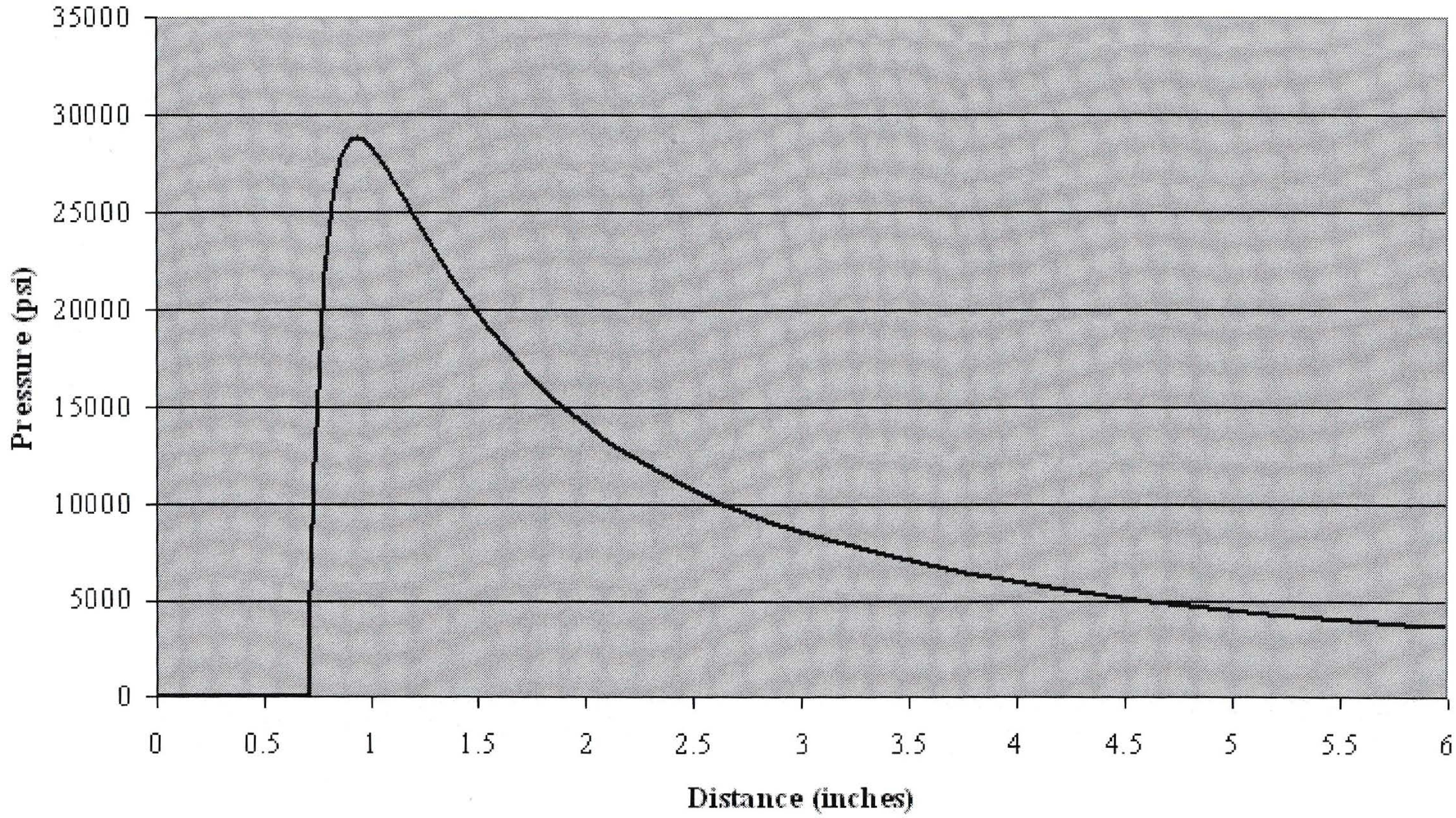
Since a gun barrel is not a closed cylinder, the only axial stresses (along the axis of the barrel) are those introduced by the recoil acceleration and the frictional forces induced by the projectile. These stresses actually reduce the effective stress and when omitted from the analysis introduce a measure of conservative design. There is an additional torsional stress from the rifling of the barrel, but here this too is ignored since it is low relative to the tangential and radial stress and seldom is considered in analyzing a barrel design.

Further manipulation of the equations shows that increasing the outside diameter does not greatly increase the strength of the gun barrel. In fact, a tube having a wall thickness equal to the bore diameter will be 84% as strong as one infinitely thick. Hence, it is not uncommon to make a barrel outside diameter three times the bore size.[14]

Stress concentration will appear any place along the barrel where a sharp transition along the barrel profile is present. Normally, larger radii will reduce the high stresses in these regions to be more acceptable.

The pressure data used in the calculations come from the pressure-versus-time curve converted to pressure-versus-distance data as previously discussed and shown in the appendix. Although the pressure at the base of the projectile is less than the chamber pressure, the differential is generally used and accepted as a safety measure.

Pressure Versus Distance
9mm 115 gr Bullet With 6 gr of Powder



For the Sten, the barrel has really only two distinct regions: a hub and a straight barrel forward of the hub. The main hub diameter of .905 sees the maximum pressure of the 9mm cartridge of approximately 29,000 psi for normal service ammunition. If we increase this, assuming the proof round pressure is 30% higher, we get a pressure of 38,000 psi to consider. It should be noted that Sten guns were not proofed, though.[15] With the inside groove diameter of the 9mm round being .357 inches, we derive the following:

The wall ratio =

$$W = \frac{D_o}{D_i} = \frac{.905}{.357} = 2.535$$

Tangential stress =

$$\sigma_t = \frac{p\,W^2 + 1}{W^2 - 1} = \frac{(38{,}000)(2.535^2 + 1)}{(2.535^2 - 1)} = 52{,}000 \text{ psi}$$

Radial stress =

$$\sigma_r = -p = 38{,}000 \text{ psi}$$

Equivalent stress =

$$\sigma_e = (\sigma_t^2 - \sigma_t\sigma_r + \sigma_r^2)^{.5} = 46{,}600 \text{ psi}$$

AISI 4140 steel in the HRC 26–32 condition has an average yield tensile strength of 96,500 psi and an ultimate strength of 125,000 psi, so the equivalent stress calculated at 46,600 yields a factor of safety of 2.1 for a proof load where:

$$\text{Factor of Safety} = \frac{\text{Material Strength}}{\text{Design Load}}$$

The factor of safety is 2.7 for a service round. Based on these calculations and type of analysis, a barrel in 4140 steel would be acceptable.

Would the barrel be safe in AISI 1140 steel where the yield strength in the annealed condition is approximately 51,000 psi and the tensile strength is 75,000 psi? The factor of safety drops to 1.4 for the service round and 1.1 for the proof load; *the reality is probably yes.*

Maj. Gen. Julian Hatcher, in his book *Hatcher's Notebook*, did testing using Springfield 03 rifles in .30-06 Springfield where he turned barrels to a .125 wall thickness and fired the barrels with regular and high-pressure cartridges with no visible effect.[16] The service round pressure was probably between 50,000 and 60,000 psi. He then turned the barrels down to a wall thickness of .062 inches. It held three regular service rounds but failed with a 75,000 psi high-pressure round. Hatcher had also tested Springfield rifles with pressures of 130,000 psi without any ill effects on the barrels.[17] Based on the equations, this should not be.

The Springfield rifle barrel has a diameter of .957 inches, 3.891 inches from the chamber end of the barrel. It uses steel with a tensile strength of 110,000 psi and a yield strength of 75,000 psi.[18] If we assume a round pressure of 57,000 psi, we achieve the following results:

The wall ratio =

$$W = \frac{D_o}{D_i} = \frac{.957}{.308} = 3.107$$

Tangential stress =

$$\sigma_t = p\,\frac{W^2 + 1}{W^2 - 1} = \frac{(57{,}000)(3.107^2 + 1)}{(3.107^2 - 1)} = 70{,}170 \text{ psi}$$

Radial stress =

$$\sigma_r = -p = 57{,}000 \text{ psi}$$

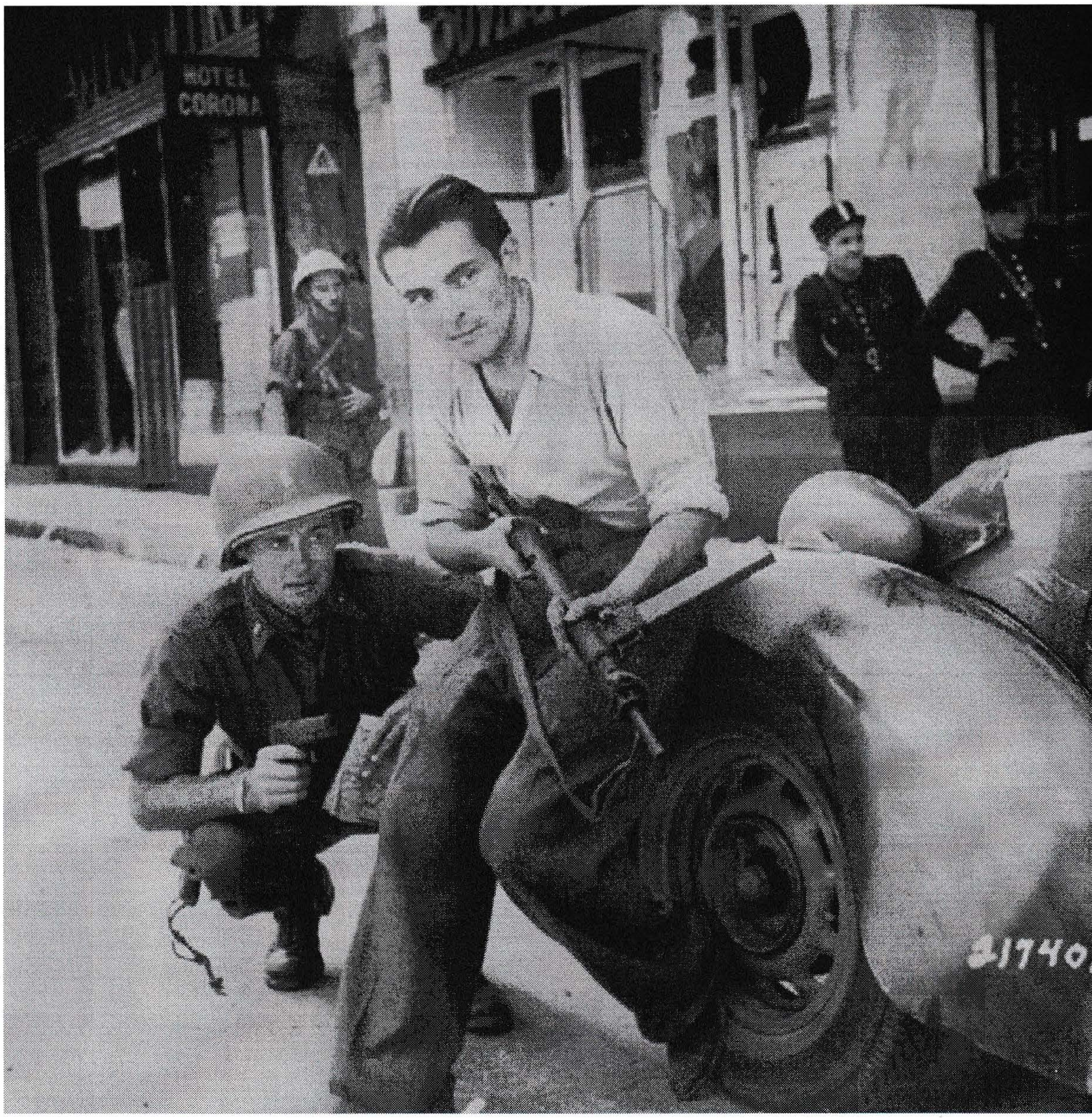
Equivalent stress =

$$\sigma_e = (\sigma_t^2 - \sigma_t\sigma_r + \sigma_r^2)^{.5} = 64{,}400 \text{ psi}$$

This puts the Von Mises equivalent stress right at a factory of safety 1.2 for a *service* round, but we know Springfield rifles can shoot thousands of rounds without barrel failure. Apparently, large safety margins are not needed for barrel design. This brings us back to the first paragraph:

> You would think that barrel design should be a major concern for a commercial gun designer. Usually it is not. There are enough examples of successful competitive or past designs that reverse engineering a proven design, and using alloy steel (read 4140 @ HRC 26–32) with a mild heat treat is usually successful and safe, whether you look at a special high-pressure overstress round test with bullets lodged in the bore ahead of the chamber, a midbore obstruction test, or a lodged bullet at the muzzle for an additional obstruction test.

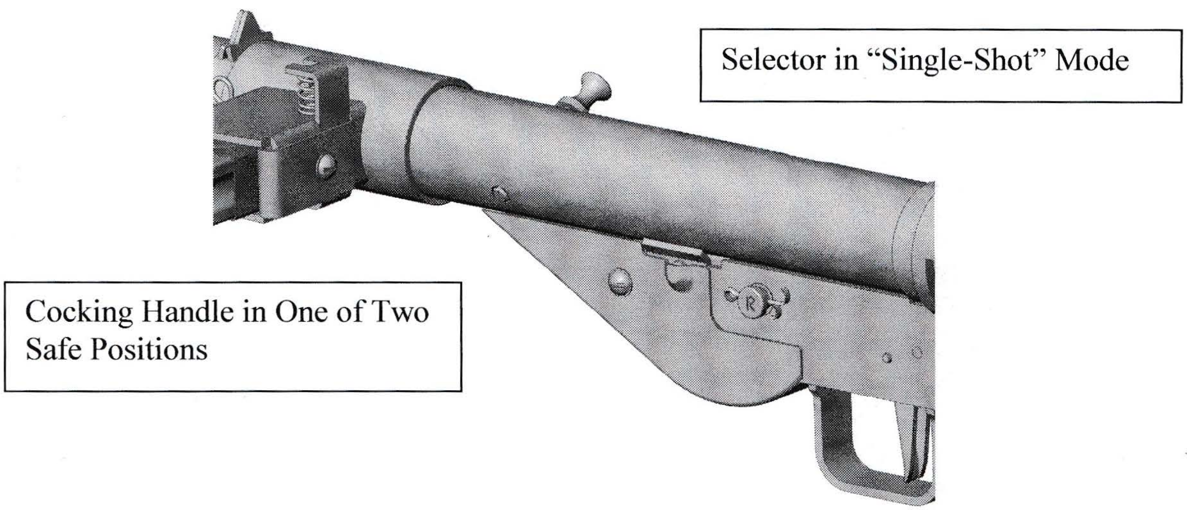
Testing bears this out.



From the National Archives and Record Administration
111-SC-217401
An American officer and a French partisan crouch
behind an auto during a street fight in a French city, 1944

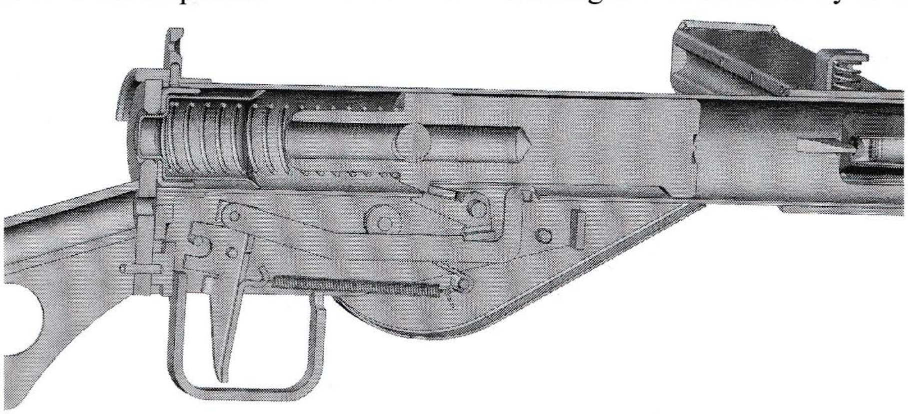
Chapter 6
Cycle of Operation

To have the gun in a safe condition there must not be a round in the chamber and the bolt must be forward against the barrel. In this position, the cocking handle can be pushed toward the interior of the gun, so that the end of the cocking handle projects into the receiver body. In this position, the bolt is secured, locked, and not allowed to move to the front or rear.



To get the gun ready to fire in *single-shot* mode you must first pull the cocking handle outward to disengage the receiver and then cock the gun so the return spring is compressed and the bolt is held from going forward by the sear. If a loaded magazine is in the gun at this point, care must be taken to not lose control of the cocking handle when pulling it rearward. If the bolt is back far enough and released inadvertently, the gun will load a round from the magazine and potentially fire the gun.

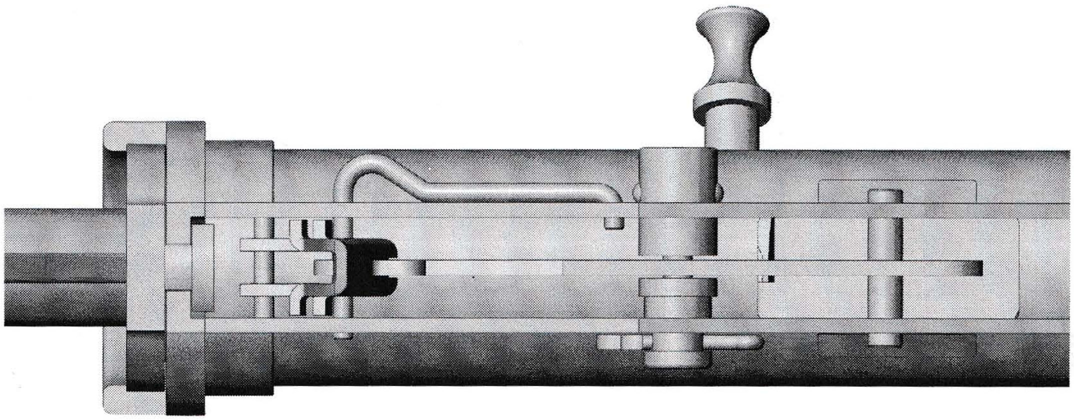
To fire the Sten submachine gun in *single-shot* (semiautomatic/repetitive) mode, the selector must be pushed so that the "-R-" marking is toward the body of the gun.



Section View Showing the Bolt in the Cocked, Ready to Fire, Single-Shot Mode

Bolt Cocked, Ready to Fire,
Single-Shot Mode

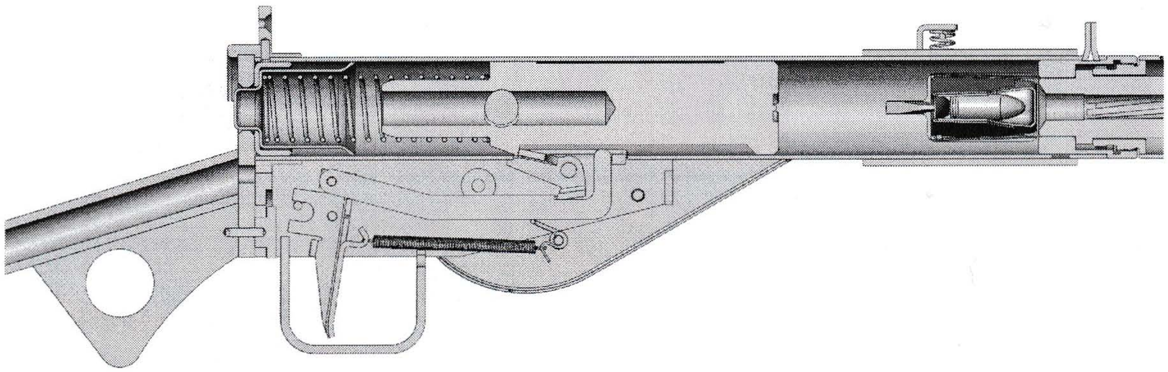
With the selector in single-shot mode, the disconnector is positioned by the selector to be in line with the gun's centerline, as shown from the bottom view of the gun below.



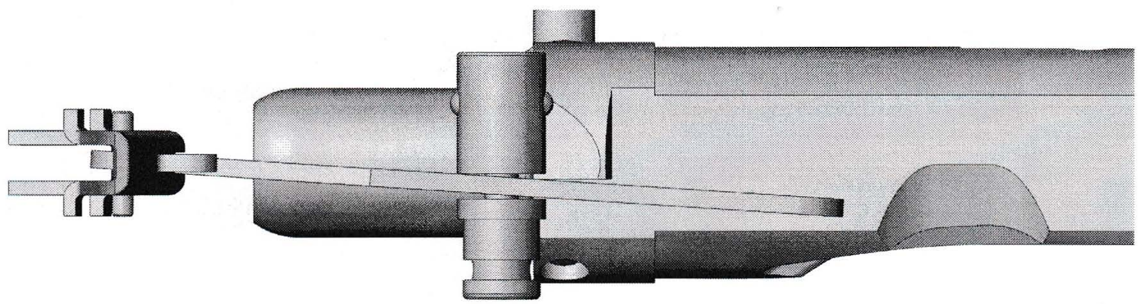
To fire the gun, the trigger is pulled. This motion rotates the trigger, causing the disconnector to move forward and rotate the sear counterclockwise. This in turn releases the bolt. The bolt is then biased forward by the compressed return spring. As the bolt moves forward, the sear stop surface on the bolt comes in contact with the disconnector, pushing it downward, and in so doing, releases the sear from the disconnector. The sear is now free and is biased by the sear spring back upward. The forward movement of the bolt continues until the two forward pick-up surfaces of the bolt contact the top round in the magazine box. This contact strips the round from the magazine box, pushing it forward where it comes in contact with the feed chamfer of the barrel, and guiding it into the chamber.

After the cartridge is seated in the chamber and is stopped by it, the extractor snaps over the rim of the cartridge, and the primer is ignited by the fixed firing protrusion on the breech bolt. Ignition of the primer ignites the powder charge and the powder burns. The round is propelled down the barrel by the powder gases and the bolt is pushed to the rear by those same powder gases through the use of the spent case as a piston. The rearward movement of the bolt compresses the return spring. The fixed ejector welded to the receiver is brought into contact with the spent case as the bolt moves approximately 1.520 inches to the rear. This contact rotates the cartridge to exit from the firearm through the ejection port of the gun.

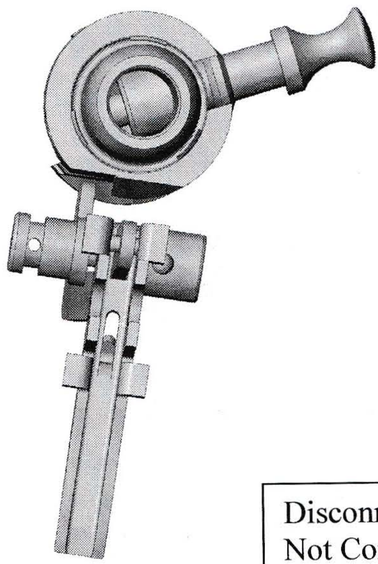
The bolt continues to the rear for approximately 5.540 inches and impacts the spring cap component at the rear of the receiver. Now the return spring takes over and forces the bolt forward until it sees the sear (engagement surface), which is biased upward by the sear spring and ready to receive the engagement surface on the bolt. The trigger must be released so the disconnector can once again rise up, return to the rear, and reengage the sear. The gun is now ready to be fired again in the single-shot mode once the trigger is pulled to the rear again.

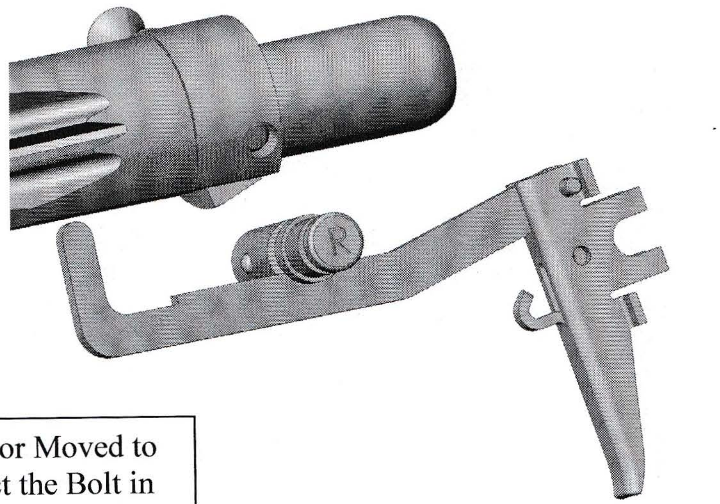


Full-automatic fire is accomplished by forcing the selector so the "-A-" side is against the body of the receiver. This motion forces the disconnector away from the centerline of the gun toward the magazine side.



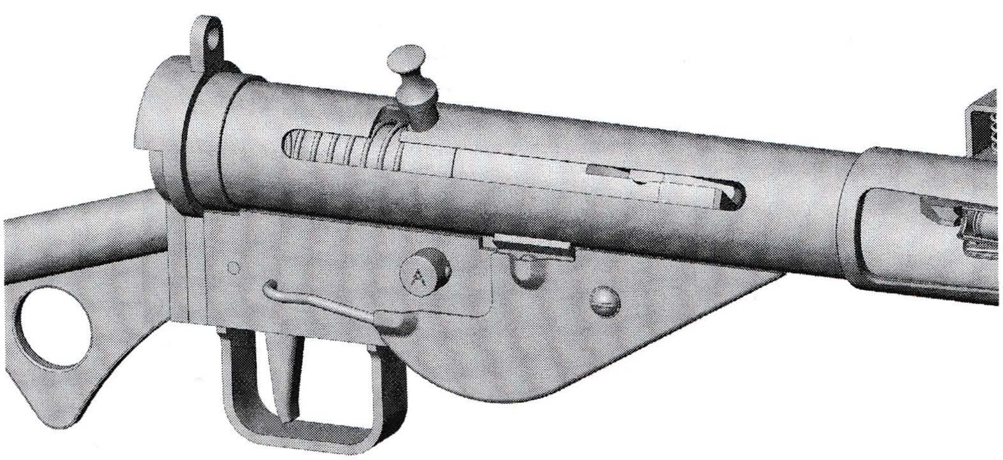
This movement moves the top of the disconnector away from the disconnector cam surface of the breech bolt so the disconnector is not moved downward away from the sear, as it is in single-fire mode. Now it always stays in contact with the sear and never releases it. This keeps the sear continuously depressed and the gun will fire automatically as long as the trigger is pulled or the magazine box runs out of ammunition. The bolt stops in the forward closed position after the last round is fired.





Disconnector Moved to Not Contact the Bolt in Automatic Mode

The Sten has an additional safety position in the receiver tube where the cocking handle can be pulled to the rear and then rotated along with the breech bolt to index into a slot meant to prevent the bolt from going forward. This is not a positive safety position, and care must be used in carrying the gun in this condition with a loaded magazine.



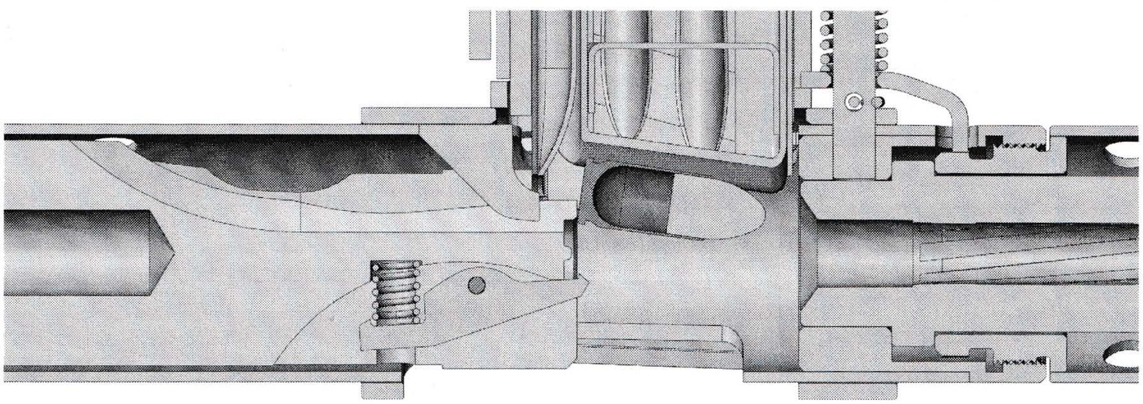
DAPDCAP565092
Ronny Jaques, National Film Board of Canada
Library and Archives Canada
. Workman Richard Chowns of Humber Bay, Ontario works burring and cleaning Sten breech blocks for inspection at the Small Arms Ltd. plant. April, 1944

Chapter 7
Feed System

Millions of Sten guns were made. Many millions of rounds were shot. Generally, a well-made gun, properly maintained was reliable and accurate. This was true even under adverse conditions of mud and sand. There were soldiers, though, who had issues with reliability. Strictly from a design standpoint, the gun could have been even better had there been more time to design it and had some changes been made.

The Sten has a magazine that positions the cartridge close to the chamber. The magazine holds the round until it just enters the chamber and then releases it.

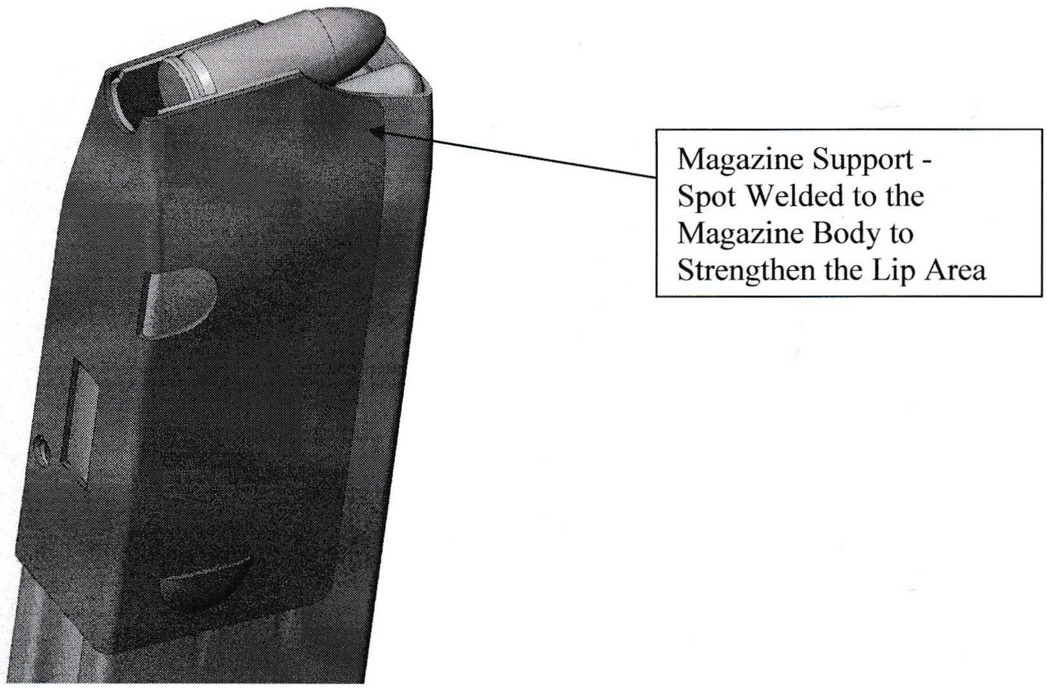
Sten Feed Geometry



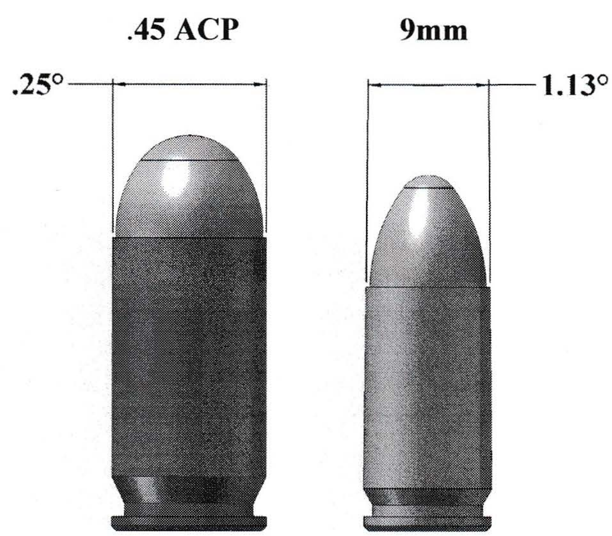
This concept is used in many guns where the magazine places the round so as to hit a ramp in order for it to guide the round into the chamber. The surface finish of the feed ramp is very important and must be smooth and free of machining rings. Polishing the feed ramp is not inappropriate, and the reliability of many guns can be improved by polishing the ramp. The improvement in reliability that can be made by having this surface polished to a mirror finish can be quite amazing as many Model 1911 gunsmiths can attest.

The Sten's magazine has the rounds staggered in the body of the magazine but funnels those rounds to a single round at the top of the magazine. This helps ensure that only one round is fed into the chamber and thus helps prevent double feeding of rounds from the magazine. The downside to this approach is that the rounds can get "jammed" trying to get to the top of the magazine due to friction and magazine geometry. In addition, there is a great deal of side pressure from the rounds on the magazine as they move to the top of the lip area from the double-stack area to the single-stack position. Double-stack magazines suffer less of this effect. The Sten's magazine needed the additional side support provided by the magazine reinforcement that was welded to the

magazine lip area to prevent rounds from bulging the magazine outward and to help guide the rounds toward the lips.



Another potential problem that exists with magazine box work is the caliber chosen. 9mm ammunition is harder to design a magazine box for than .45 ACP ammunition due to the side angle of the ammunition itself.

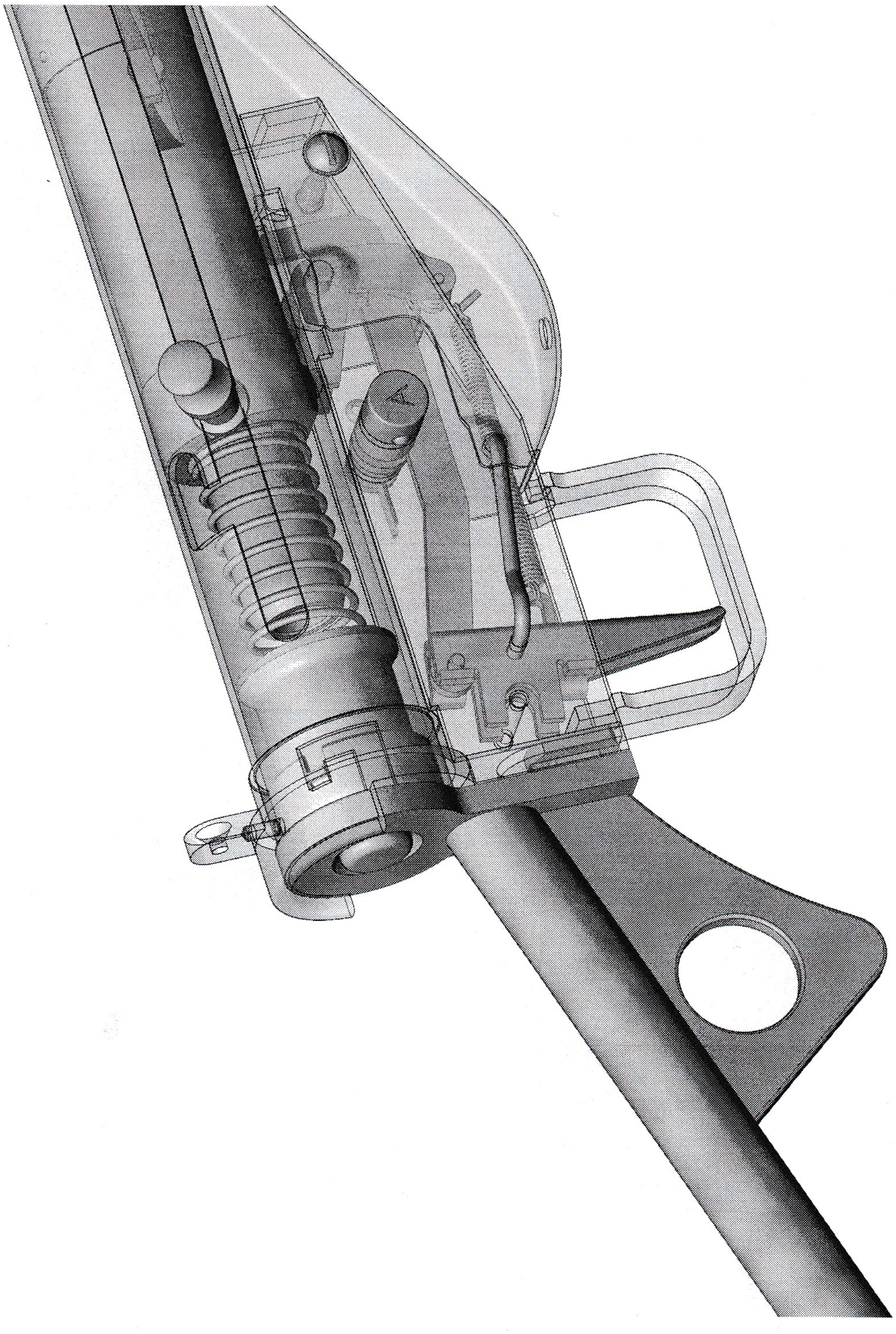


.45 ACP ammunition has an included angle of .25°. 9mm has well over four times that amount with an included angle of 1.13°. In a 30-round straight magazine box, this becomes an issue as the stacking of the rounds makes the follower design difficult. It can be solved by curving the magazine box slightly, as is the case with the British Sterling submachine gun, rather than making it straight, as the Sten, since the rounds have a natural inclination to curve due to the cartridge's sidewall angle. In pistol magazines, the problem is helped by having the box at an angle and not straight.

Another flaw with the Sten's feeding approach is the position of the magazine on the side of the gun rather than vertical, as it is in many other gun systems. Placing the magazine box on the side of the gun means that the entire weight of the magazine, especially fully loaded, wants to angle the magazine box relative to the chamber opening as it takes up the clearance between the magazine and magazine housing.[19] This was also complicated when soldiers would hold the magazine housing of the Sten and bias the magazine box and cartridges relative to the feed ramp rather than holding the gun by the front heat shield as training indicated they should. A vertical magazine box is more consistently located during the feeding cycle. The downside to this is when the individual is lying flat or prone on the ground, the magazine position makes it difficult to operate the gun. Reliability is more of a priority for most users.

Another subtle design shortcoming of the Sten was the lack of a last-shot round hold-open device to keep the bolt to the rear once the gun had fired the last round. This was a feature for the Thompson submachine gun. This feature is usually provided by a lever that is moved upward by the magazine follower and stops the forward motion of the bolt once the gun has fired the last shot. This lets the user know the gun is empty and makes insertion of the next magazine easier since the bolt is out of the way and not trying to depress the cartridges as the new box of ammunition is inserted. This is a nice feature but not a necessity, as the Sten proved.

There was no time for any of this. Guns were needed immediately and a magazine design that was deemed acceptable already existed. The Sten was designed around the magazine, which was a copy of the German MP-28/Lanchester. Using the same type of ammunition and magazines as your enemy in time of war can help your soldiers in time of need when supplying them is difficult. The Sten was used well past the end of World War II and by many different countries, a fact that speaks well to the gun's overall reliability, durability, and manufacturing standards as designed and constructed. It was ugly, it was cheap, and it was effective.



Chapter 8
Technical Drawings

The following drawings represent a "-best effort-" to reverse engineer a single gun sample of a Sten. The drawings of the large components are categorized by individual operations to make the part requirements clear. Part-cut sequencing was done for convenience and not according to any engineering or machining requirement. The material selections and heat treats provided are what one would normally expect to be specified with the steels available today.

Generally, the springs used in the Sten are very well designed. The stress levels are low so that even under dynamic loading, the springs should not take a "set" and lose spring force. Calculations for the springs are provided using precision-grade tolerancing to improve consistency from gun-to-gun function. These calculations can be made by hand, but software is available from the Spring Manufacturers Institute that makes this process extremely easy and understandable.

The Sten submachine gun was a complete departure from the Thompson submachine gun in how it was designed and constructed. By using stampings, simple turned components, and simple weldments, it could be made much less expensively than the Thompson submachine gun with its wood stock and forend, castings, and machined components. While the components were simple in design for the Sten, there were still quite a few of them, as you will see in the following drawing package.

George Dmitrieff's book "Submachine Gun Designer's Handbook" was used to compare dimensions from a parts-kit gun to his drawings.[20] In many cases there were disagreements between dimensional figures or dimensions missing, and in those cases, the actual part dimensions from components were used or a best-fit solution found. The sear design shown in the following drawings is the stamped design from the parts kit and not the machine design that was also used and described in Dmitrieff's book.

The magazine components presented the most difficulty in reverse engineering. The magazine follower in particular would need to be discussed with the stamping vendor given the job to make this component. This sort of progressive stamping with its unique fold-over design, presents difficulties in translating to a piece of paper. In all likelihood, functional gauging would be used to inspect this part for conformance. As indicated previously, magazine design and function can be the trickiest aspect of any gun project.

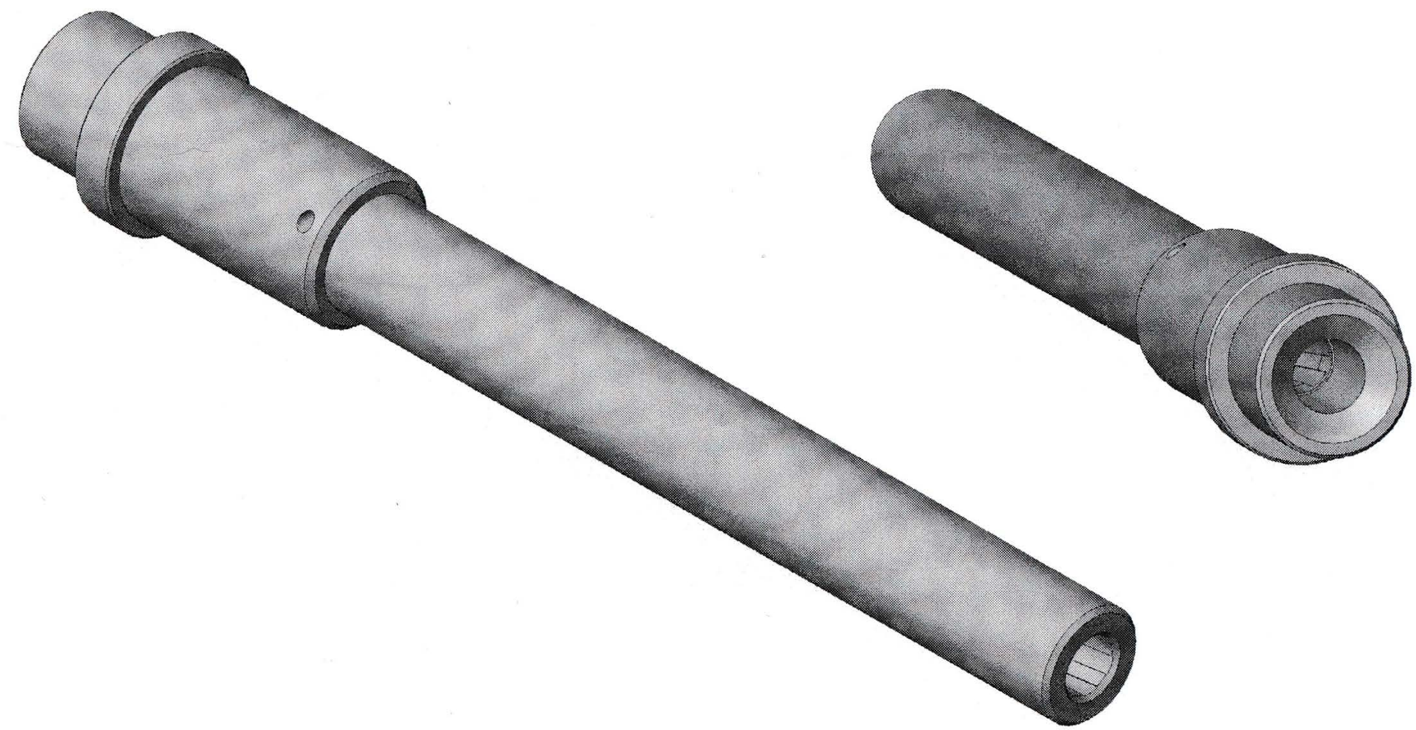
The barrel design shown in the drawings reflects a one-piece design. In Peter Laidler's book "The Sten Machine Carbine" he indicates that the barrel is in reality an assembly of three components.[21] With today's equipment and costs of assembly, making this a one-piece design makes the most sense. The drawings reflect that.

Sten Parts List

- Barrel
- Barrel Nut Assembly
    - Barrel Nut
    - Heat Shield
- Bolt Assembly
    - Bolt
    - Extractor
    - Extractor Pivot Pin
    - Extractor Spring
- Cocking Handle
- Cotter Pin (2)
- Disconnector
- Disconnector Pivot Pin
- Lock Washer (2)
- Magazine Box Assy, Complete
    - Magazine Assembly
        - Magazine Box
        - Magazine Support
    - Magazine Box Bottom
    - Magazine Box Retainer
    - Magazine Follower Assembly
        - Magazine Follower
        - Mag. Follower Support
    - Magazine Spring
- Magazine Housing Assy, Complete
    - Magazine Housing Assy
        - Mag. Housing Tube
        - Mag. Latch Housing
        - Mag. Latch Stud
    - Barrel Nut Catch
    - Hitch Pin
    - Lock Washer
    - Magazine Latch
    - Magazine Latch Spring
    - Magazine Housing Spacer
    - Magazine Housing Plunger
    - Plunger Spring
    - Screw
- Receiver Assembly Complete
    - Receiver Bottom Sub-Assy
        - Rec. Housing Front Support
        - Side Plate Left Hand

Receiver Assembly Complete (Continued)

- Side Plate Right Hand
    - Side Plate Blank (2)
- Trigger Guard
- Trigger Stop Pin
- Receiver Top Subassembly
    - Rec. Rear End Bushing Assy
        - Rec. Rear End Bushing
        - Rec. Rear Bushing Bottom
    - Ejector
    - Receiver
    - Front Sight (2)
    - Receiver Bushing
    - Rear Sight
    - Rear Sight Locating Pin
- Return Spring Assembly
    - Return Spring
    - Return Spring Handle Clip
- Screw (2)
- Selector Assembly
    - Selector Button
    - Selector Detent Ball
    - Selector Spring
- Stock Assembly
    - Butt Plate
    - Stock Face
    - Stock Stud
    - Stock Stud Locating Pin
    - Stock Support
    - Stock Tube
- Spring Retainer
- Spring Cap
- Sear Assembly
    - Sear
    - Sear Spring Pin
- Sear Pivot Pin
- Sear Spring
- Trigger
- Trigger Housing Cover
- Trigger Pivot Pin
- Trigger Spring



Dimensions are in Inches

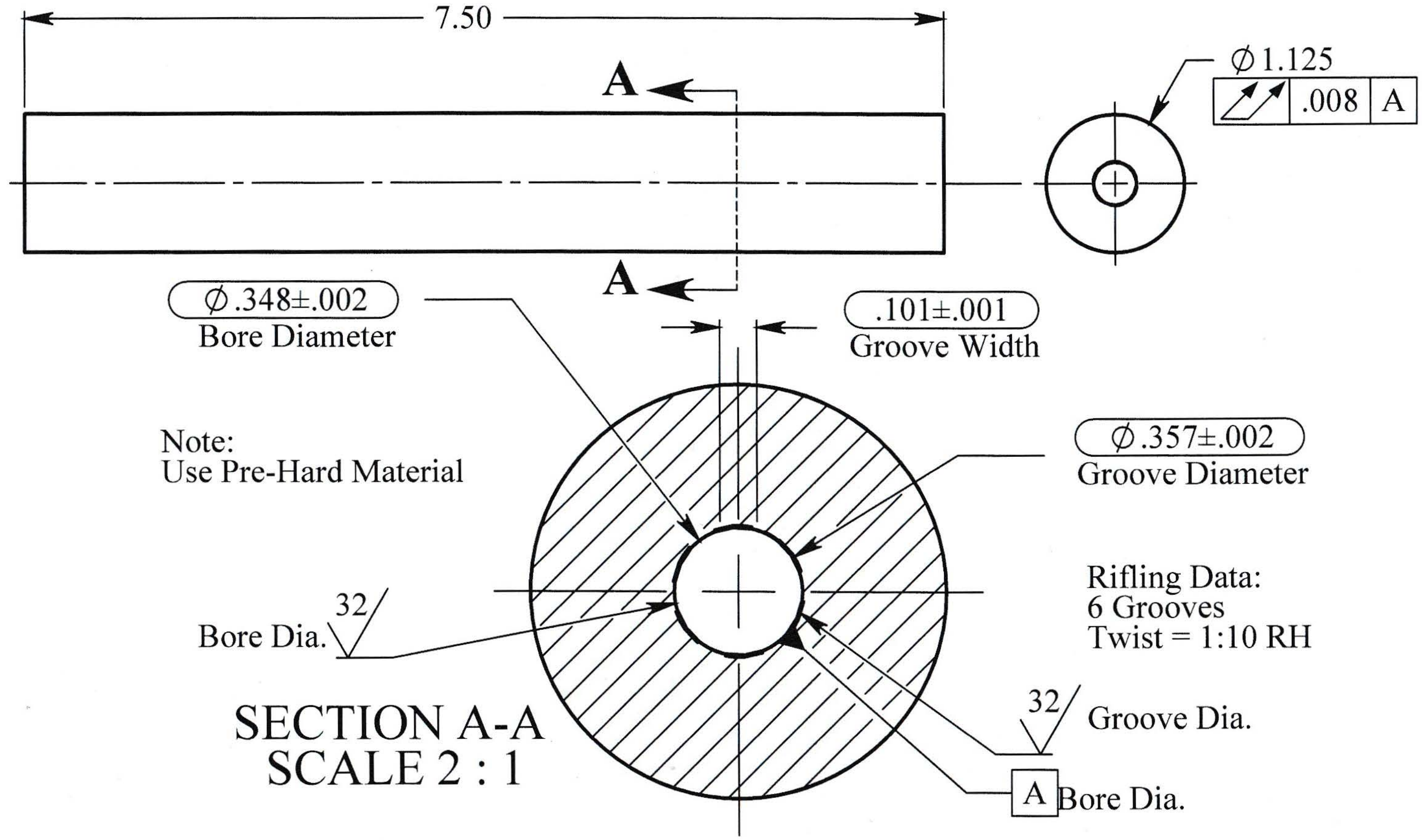
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

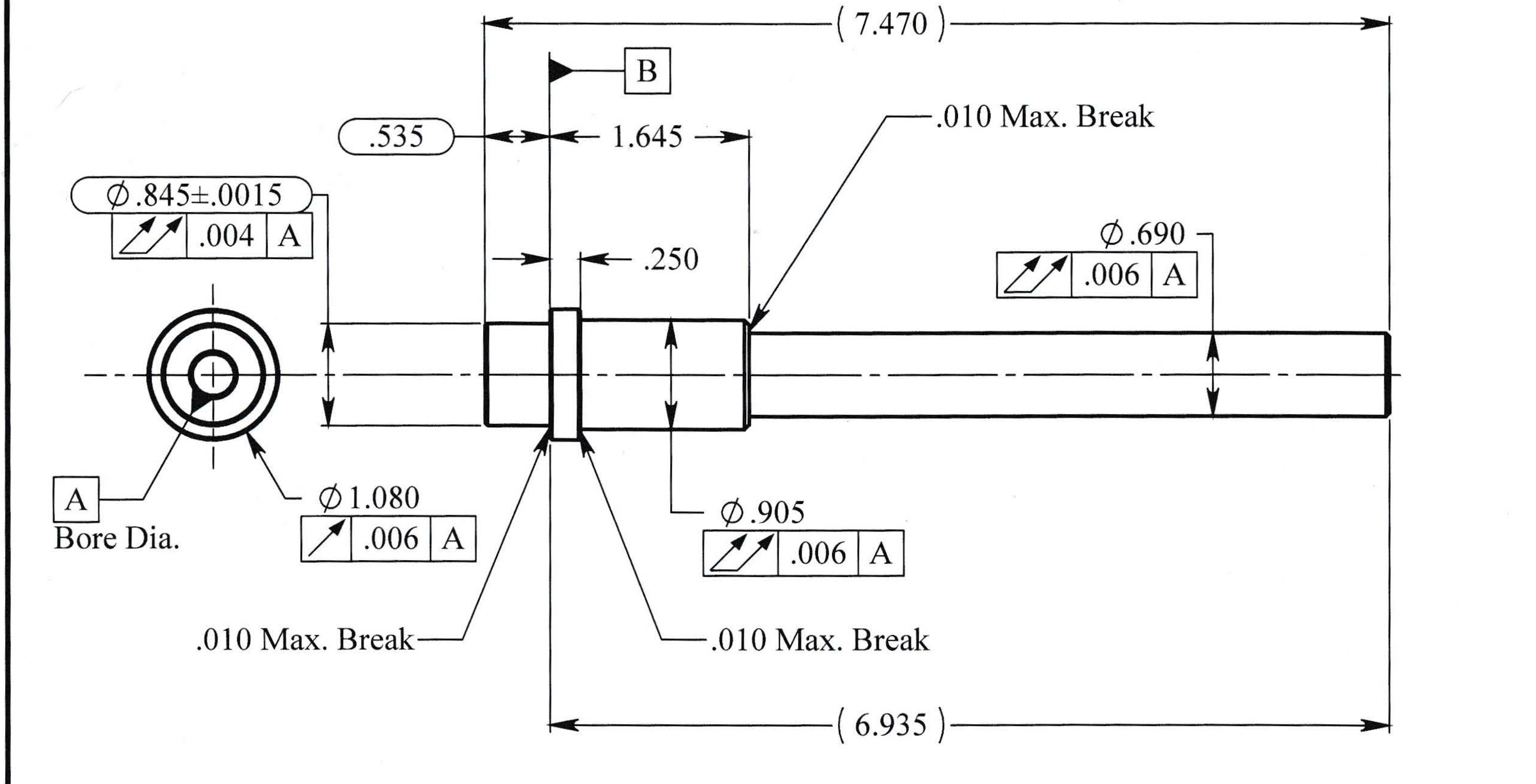
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

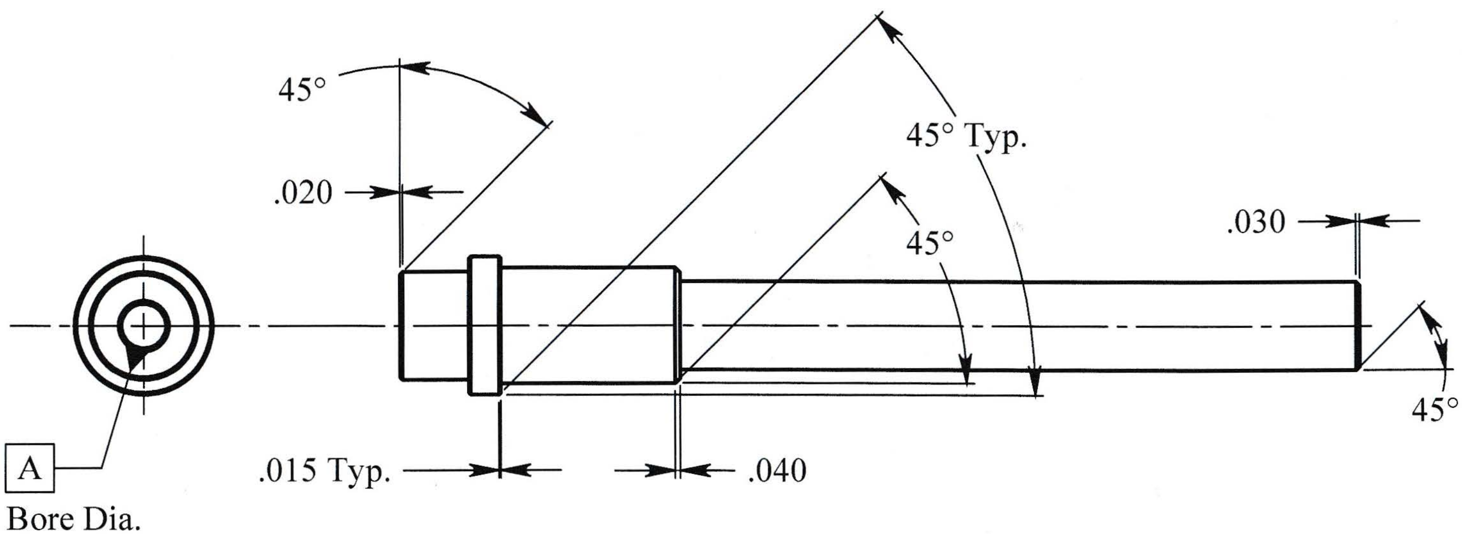
MATERIAL	STEN MK II
HEAT TREAT	PART NAME Barrel
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:1



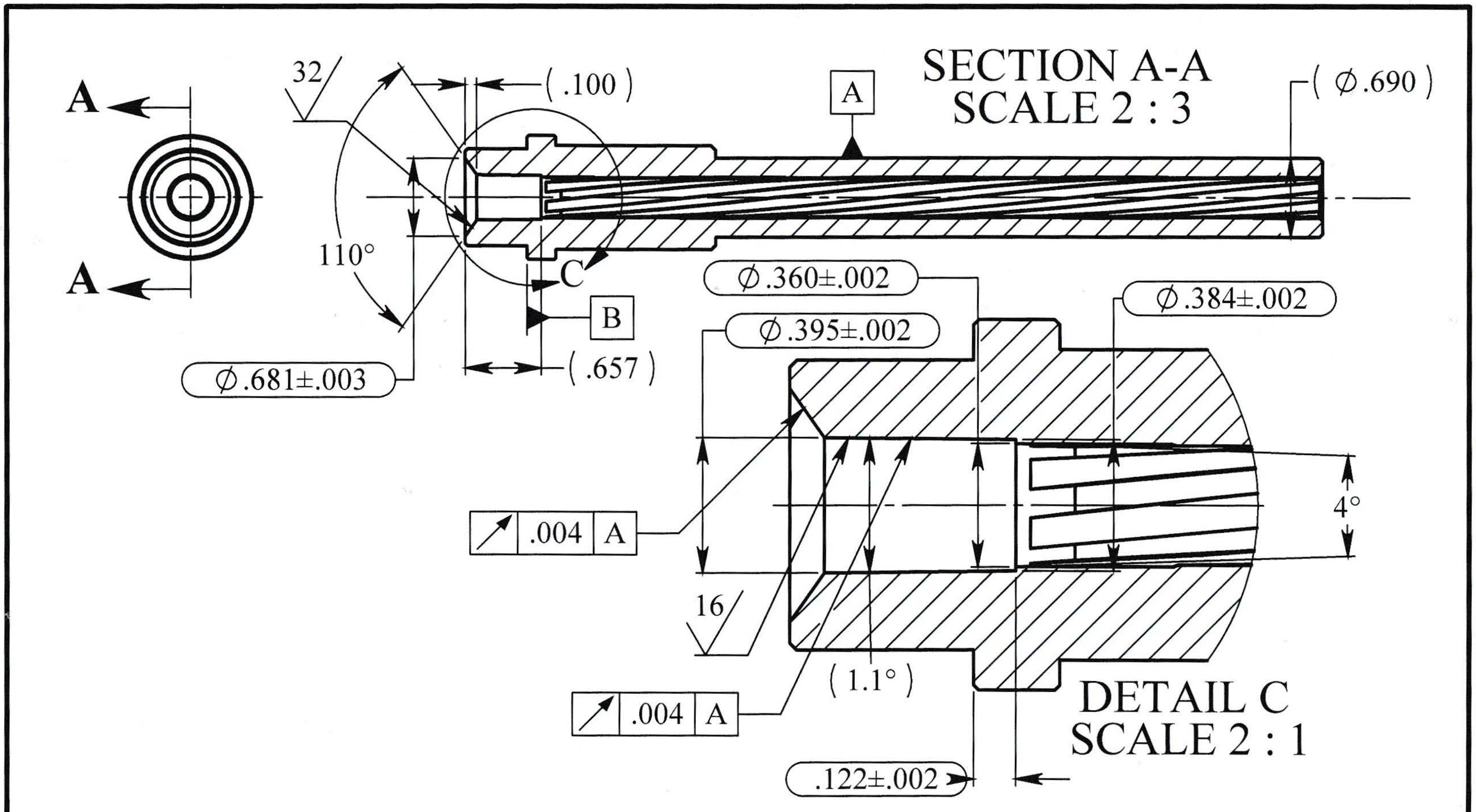
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT Harden & Temper	PART NAME Barrel Blank
		HARDNESS HRC 26 - 32	OPERATION NAME Rifling
	Proprietary and Confidential	FINISH None	OPERATION NO. 10 — SCALE 2:3



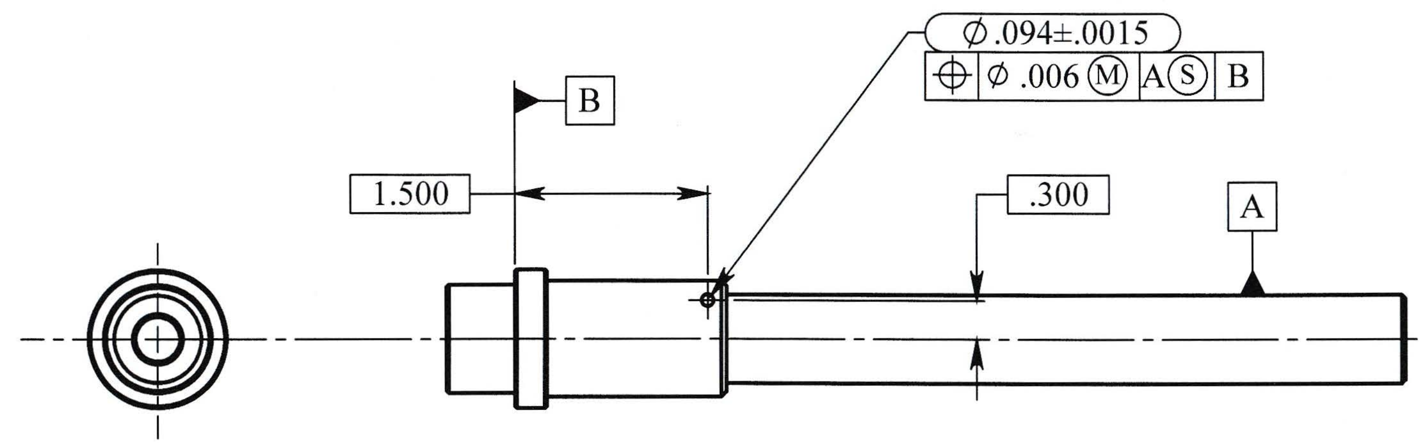
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 4140 Ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Barrel OPERATION NAME Outside Profile OPERATION NO. 20 SCALE 2:3



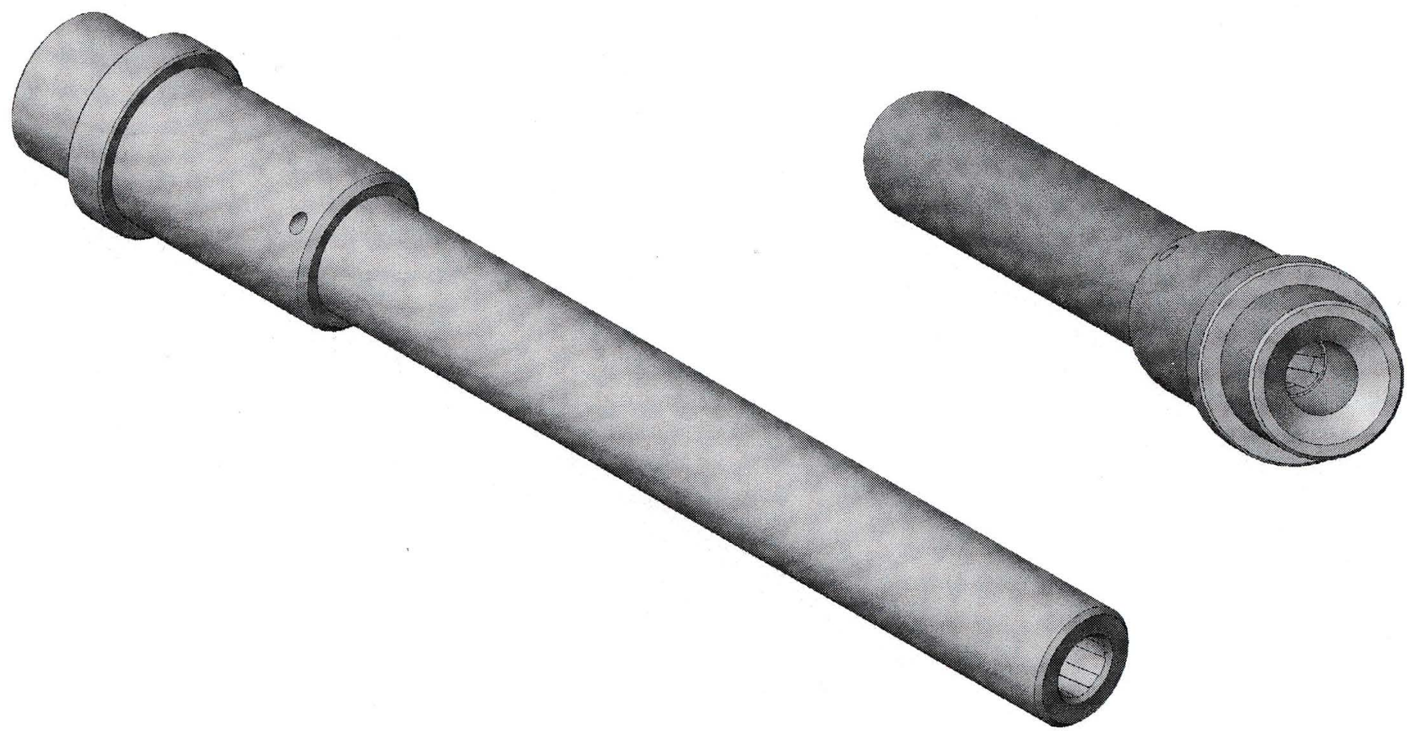
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 4140 ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Barrel OPERATION NAME Chamfers OPERATION NO. 30 SCALE 2:3



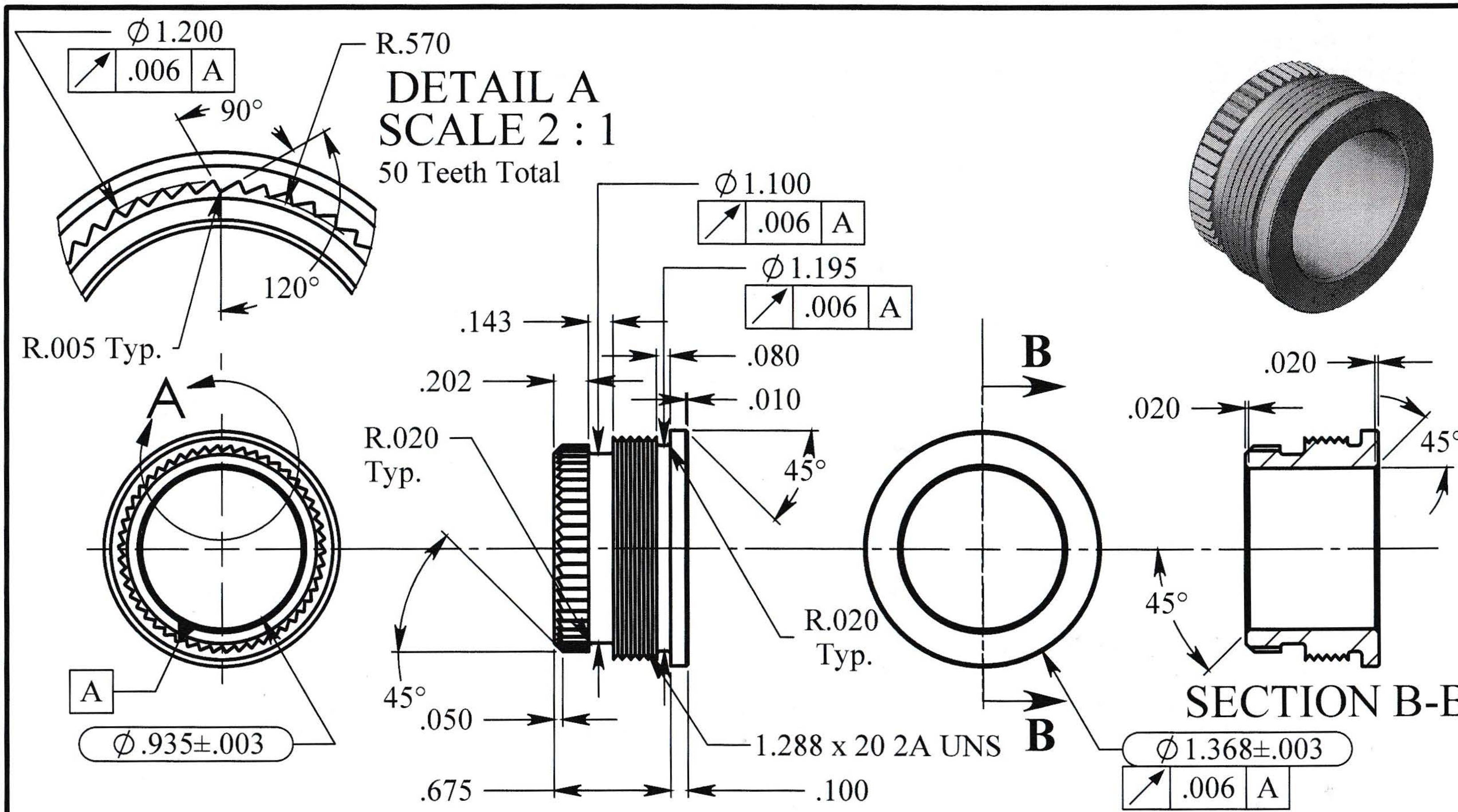
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX) Proprietary and Confidential	MATERIAL AISI 4140 Ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Barrel OPERATION NAME Chamber OPERATION NO. 40 SCALE 2:3



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ⟵(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ⟵(C .XXX) Proprietary and Confidential	MATERIAL AISI 4140 Ref.	STEN MK II
		HEAT TREAT	PART NAME Barrel
		HARDNESS	OPERATION NAME Retainer Hole
		FINISH	OPERATION NO. 50 — SCALE 2:3

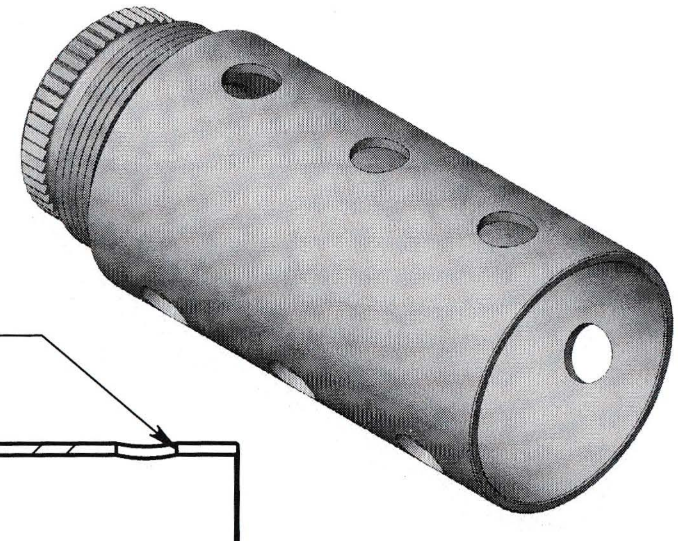


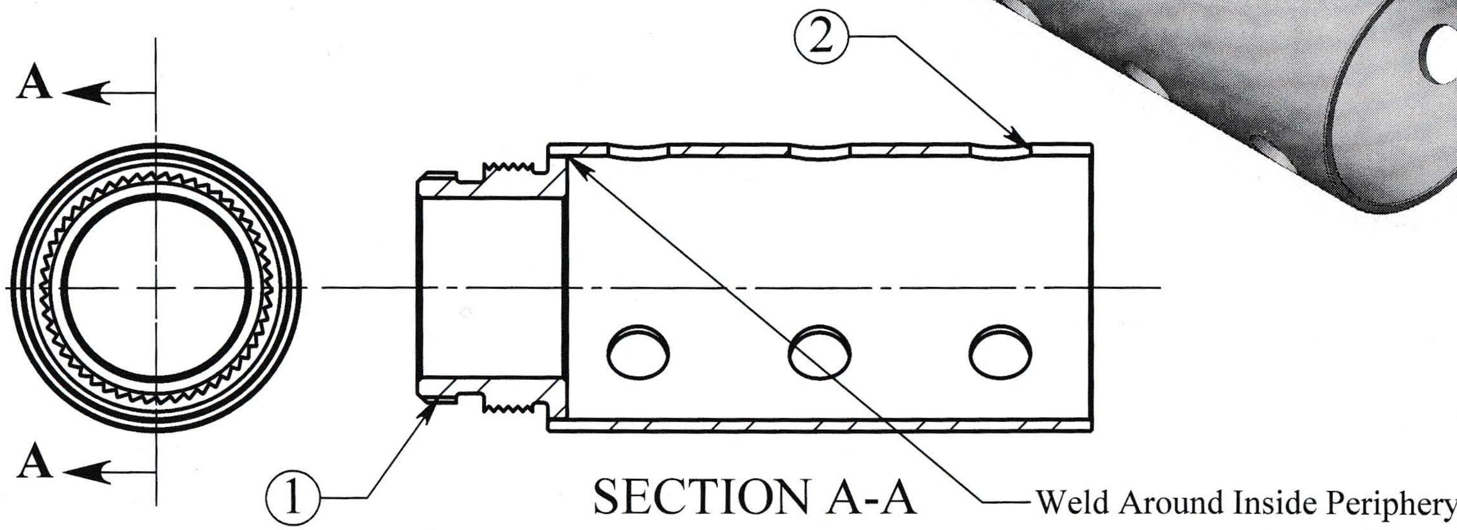
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance →| |← (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |← (C .XXX) Proprietary and Confidential	MATERIAL AISI 4140 Ref. HEAT TREAT Harden & Temper Ref. HARDNESS HRC 26- 32 Ref. FINISH Black Oxide	STEN MK II PART NAME Barrel OPERATION NAME Finishing OPERATION NO. 60 SCALE 1:1



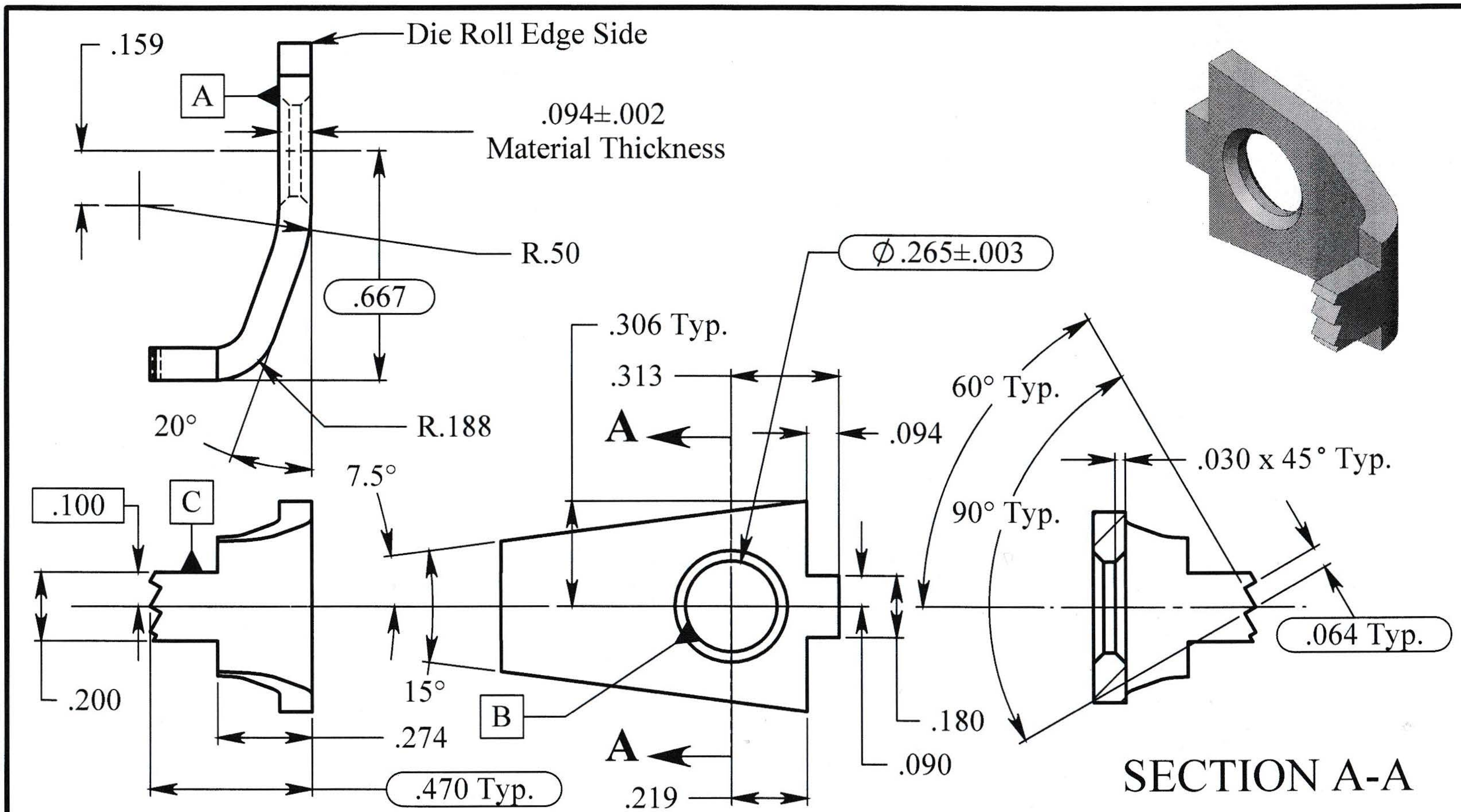
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT Austemper	PART NAME Barrel Nut
		HARDNESS HRC 40-45	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 1:1

ITEM NO.	PART NUMBER	QTY.
1	Barrel Nut	1
2	Heat Shield	1

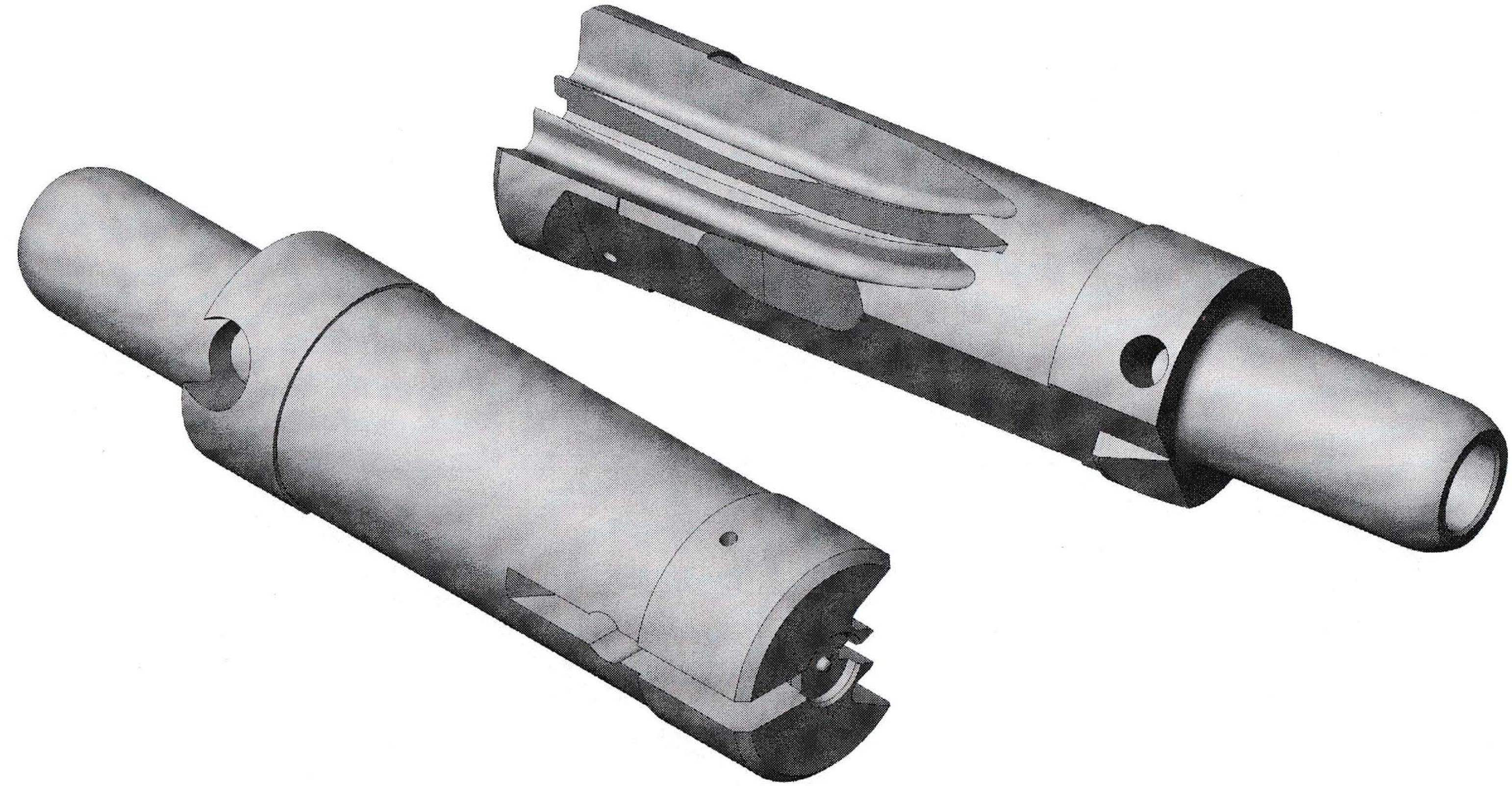




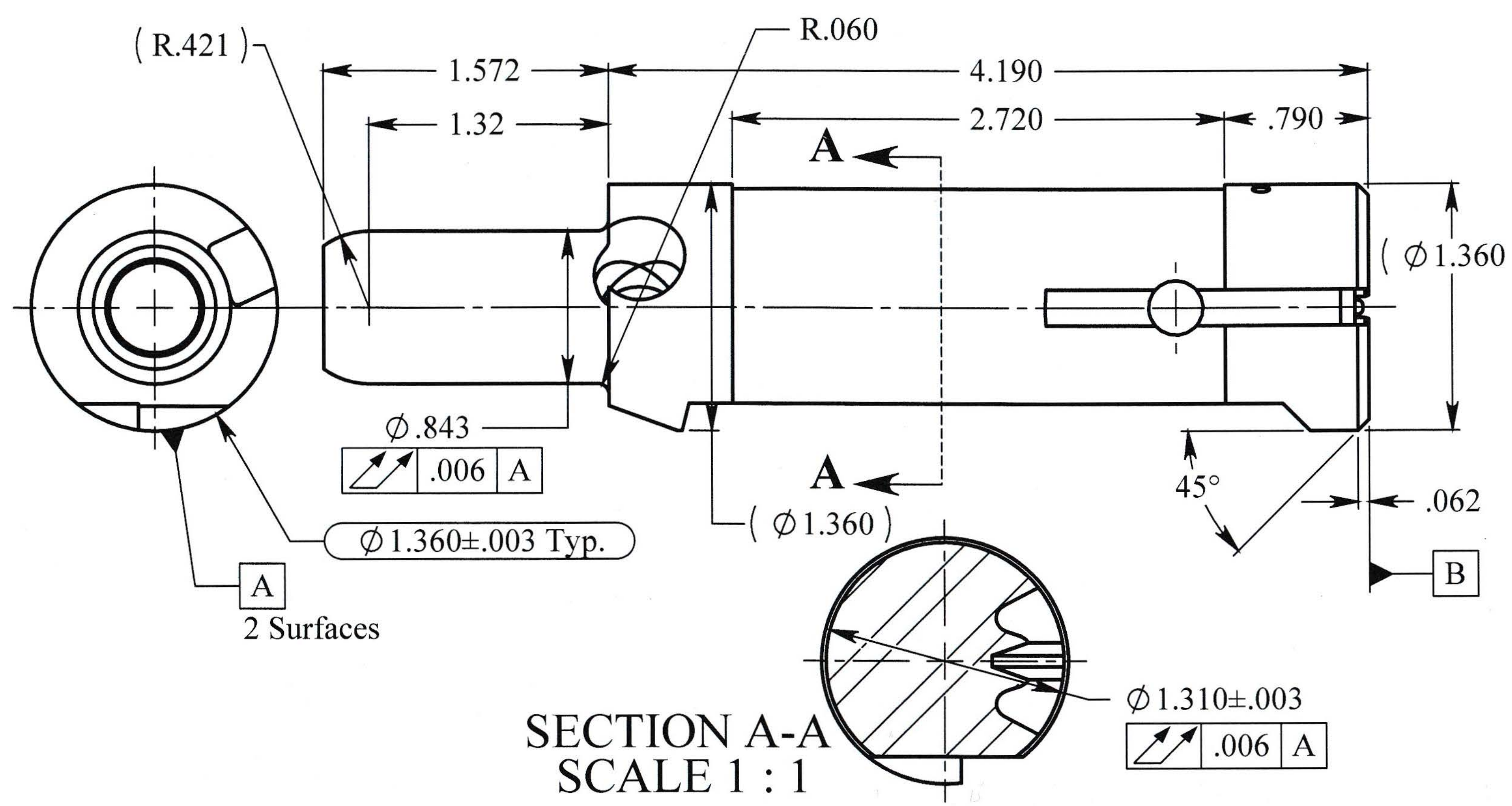
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH Black Oxide	STEN MK II PART NAME Barrel Nut Assy OPERATION NAME OPERATION NO. SCALE 1:1



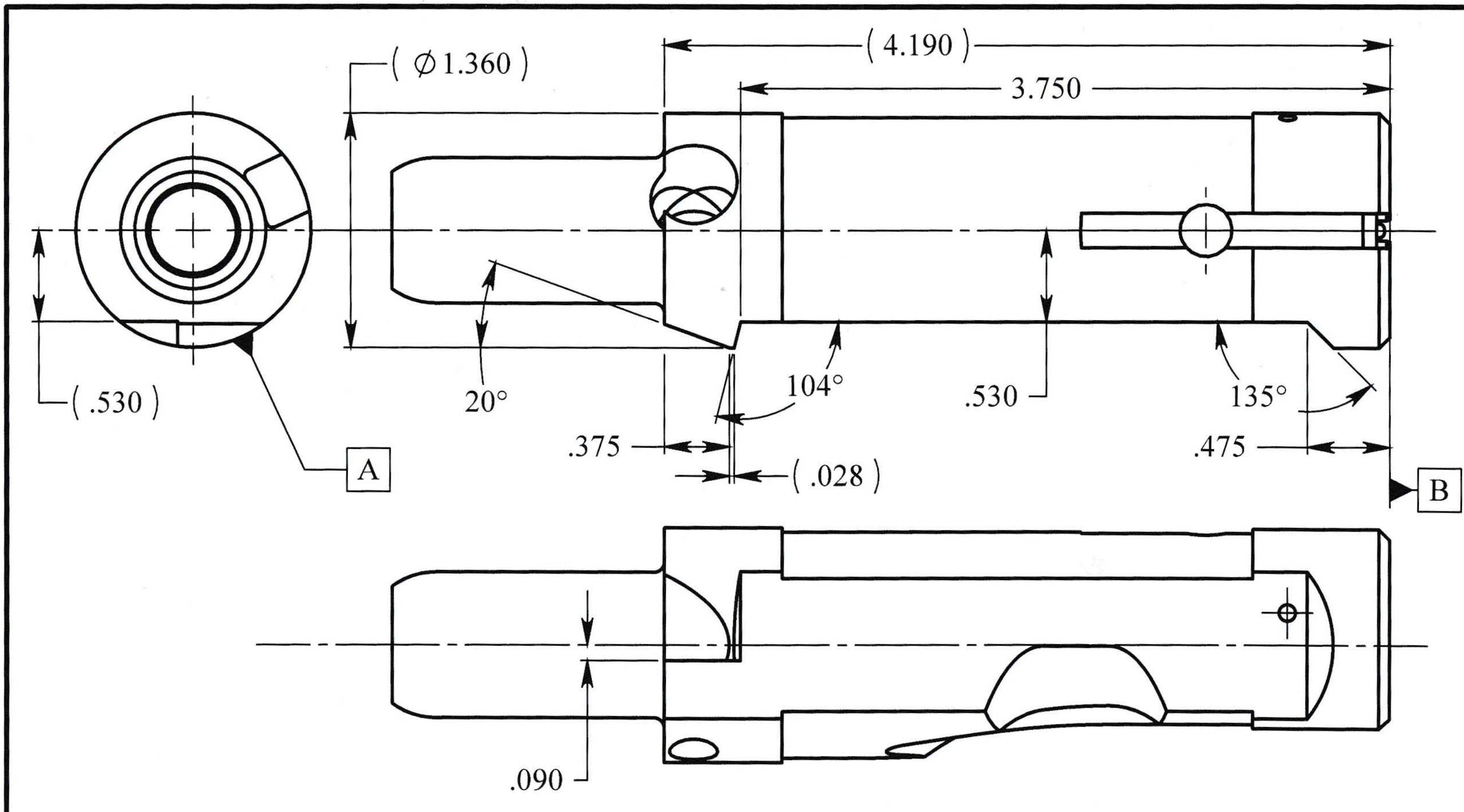
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX) Proprietary and Confidential	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT Carburize .7 C	PART NAME Barrel Nut Catch
		HARDNESS HR15N 88-92	OPERATION NAME
		FINISH Black Oxide	OPERATION NO. / SCALE 1:2



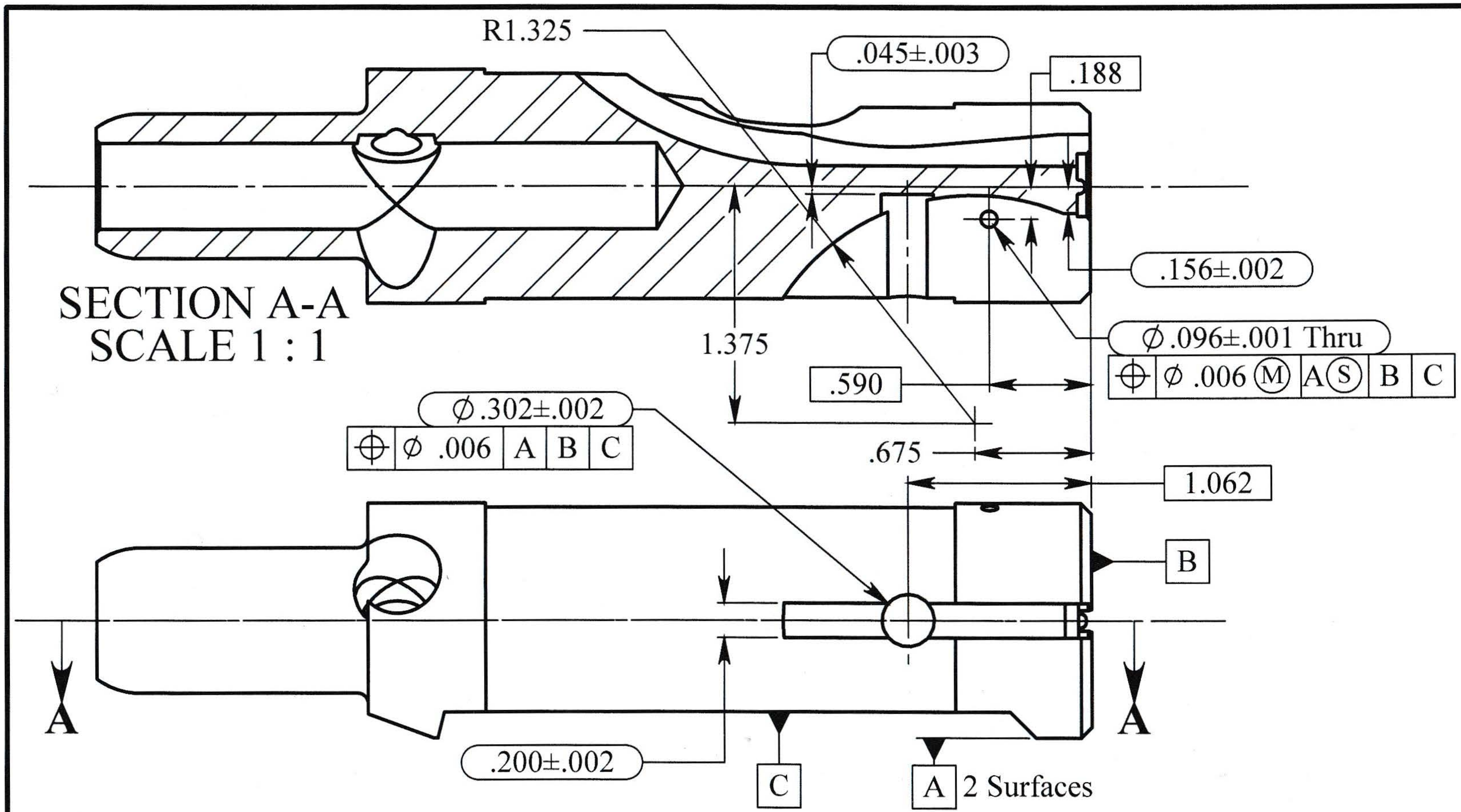
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 4140 HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Bolt OPERATION NAME OPERATION NO. SCALE 1:1



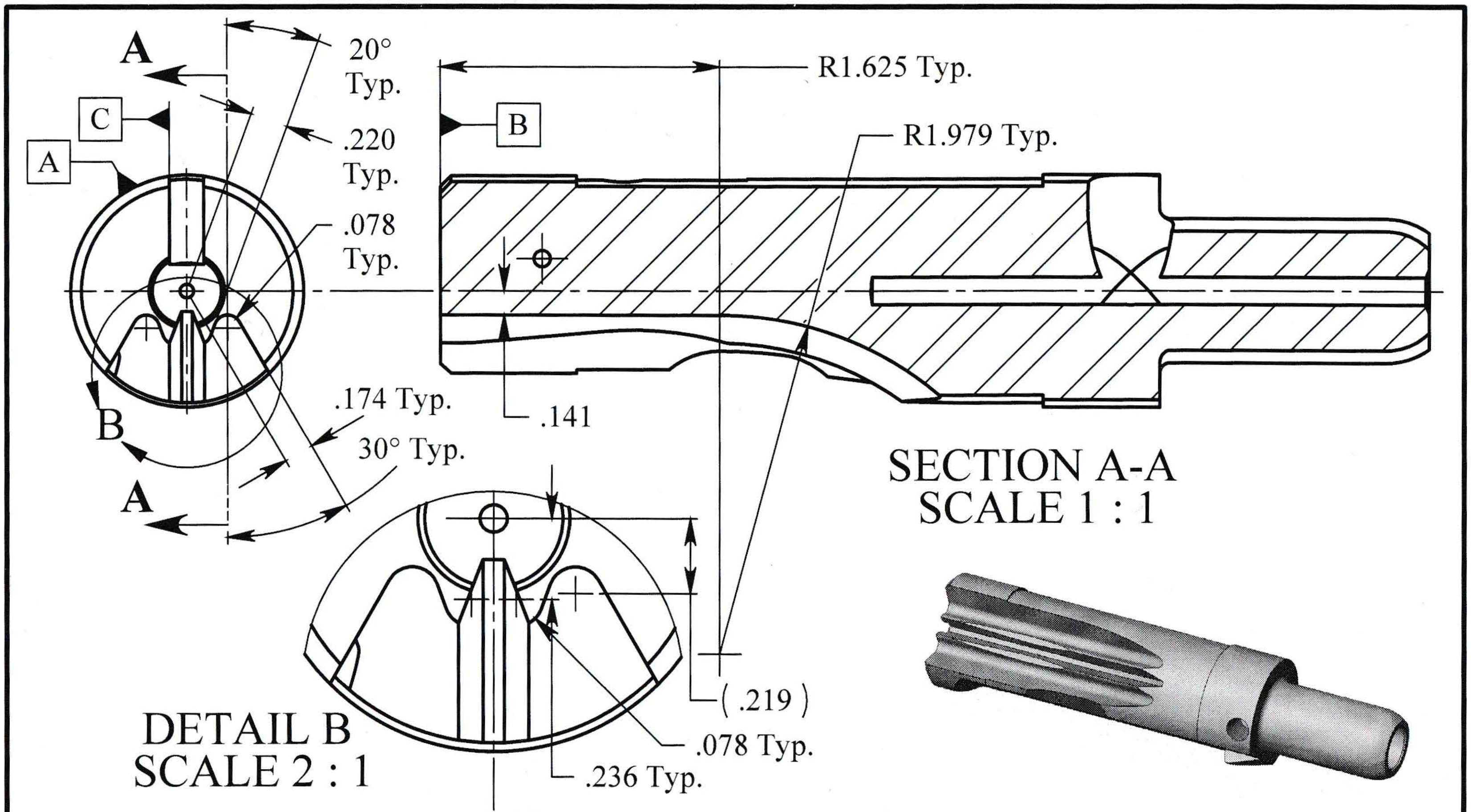
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 4140 (Ref.)	STEN MK II
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Outside Contour
	Proprietary and Confidential	FINISH	OPERATION NO. 10 / SCALE 1:1



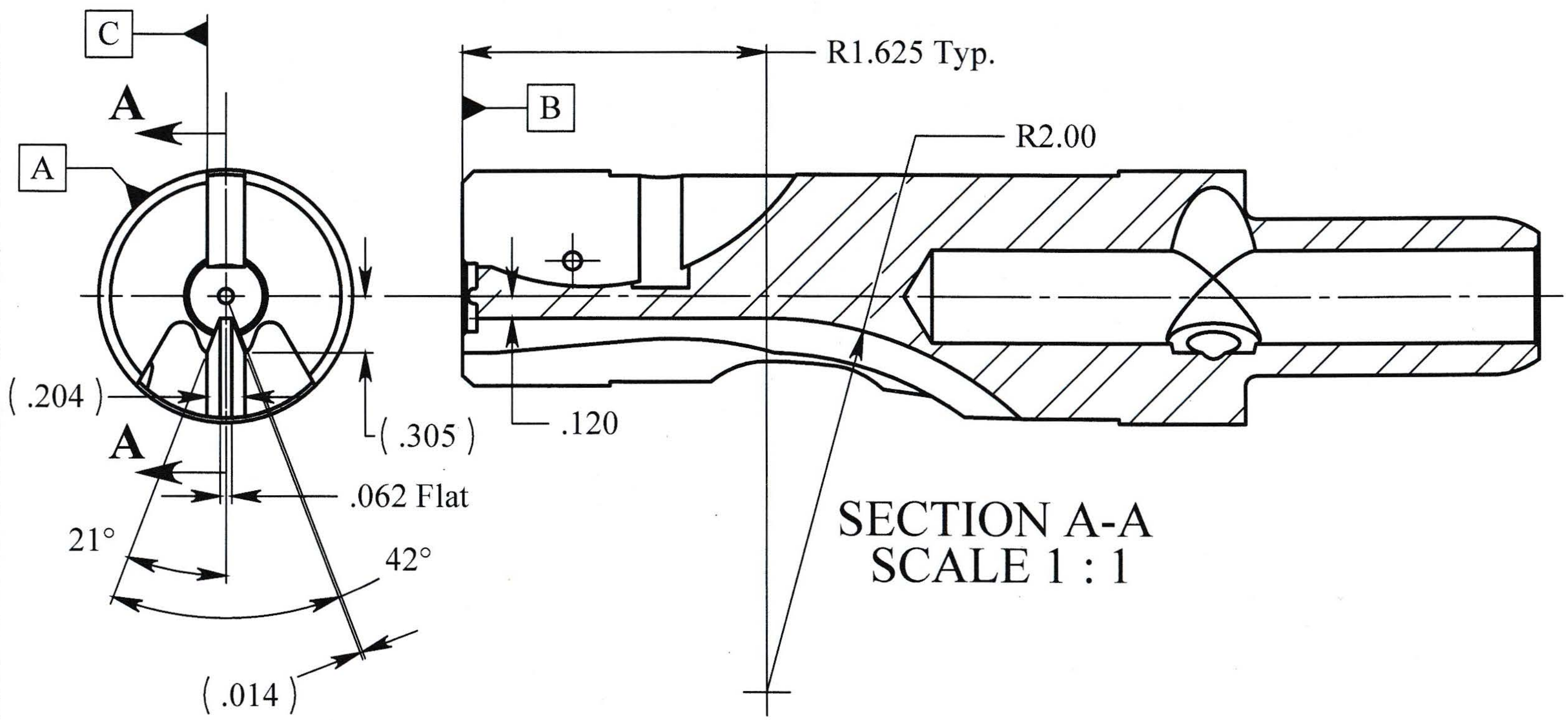
Dimensions are in Inches	Notes:	MATERIAL	STEN MK II
Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)	AISI 4140 Ref.	
		HEAT TREAT	PART NAME Breech Bolt
	2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	HARDNESS	OPERATION NAME Bottom Cut
	Proprietary and Confidential	FINISH	OPERATION NO. 20 — SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Extractor Cuts
	Proprietary and Confidential	FINISH	OPERATION NO. 30 — SCALE 1:1

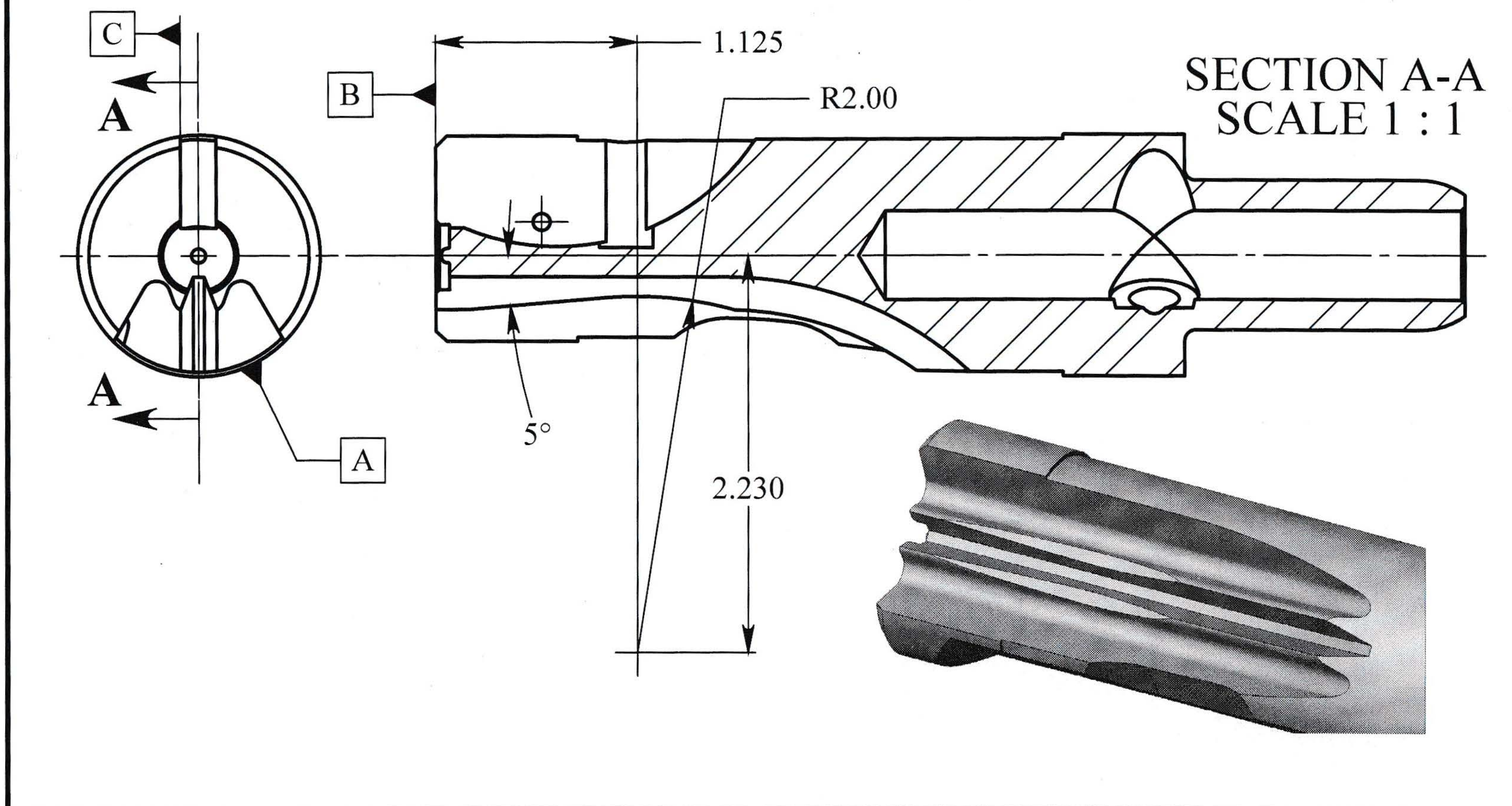


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 4140 Ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Breech Bolt OPERATION NAME Magazine Clearance 1 OPERATION NO. 40 SCALE 1:1

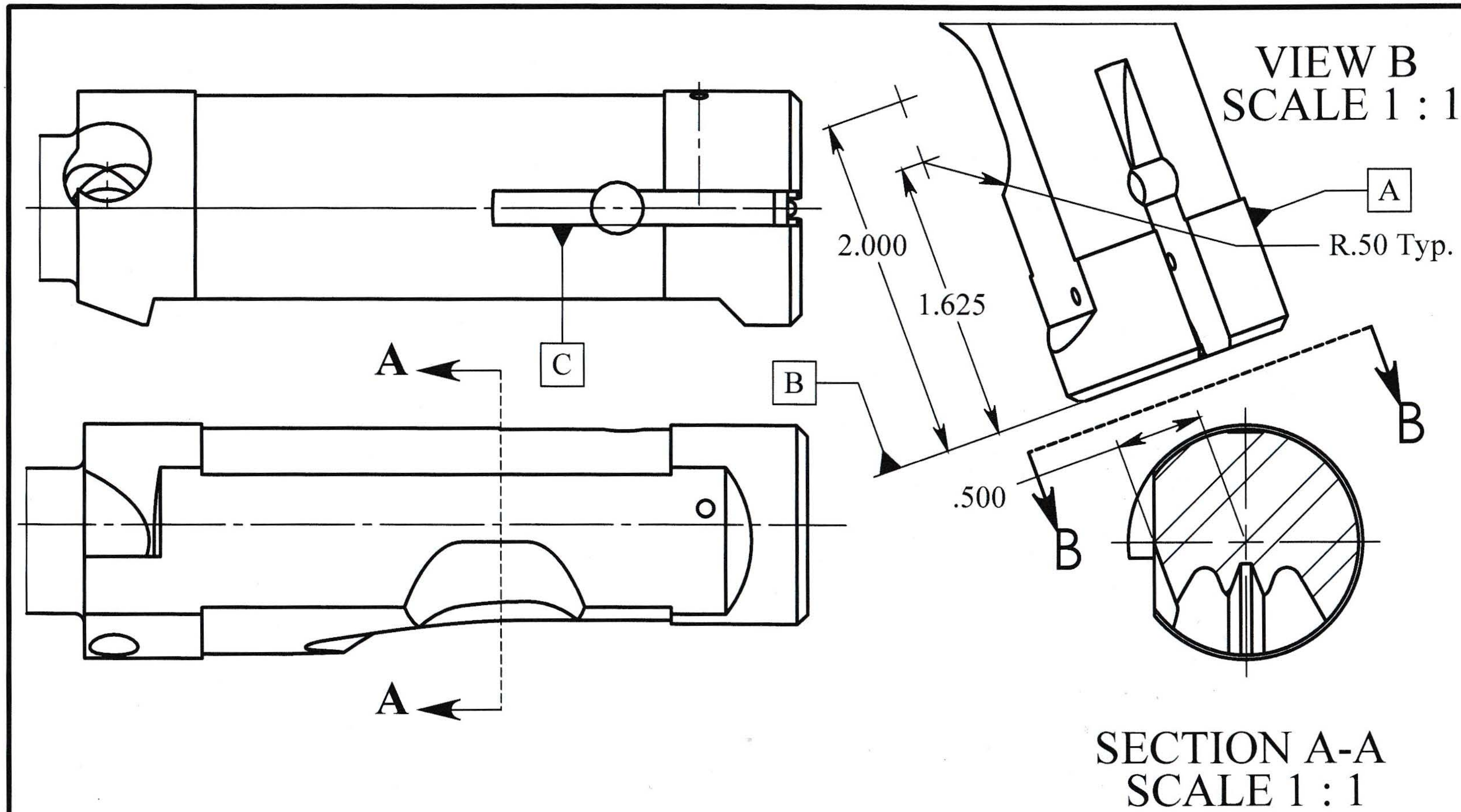


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 4140 HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Breech Bolt OPERATION NAME Magazine Clearance 2 OPERATION NO. 50 SCALE 1:1

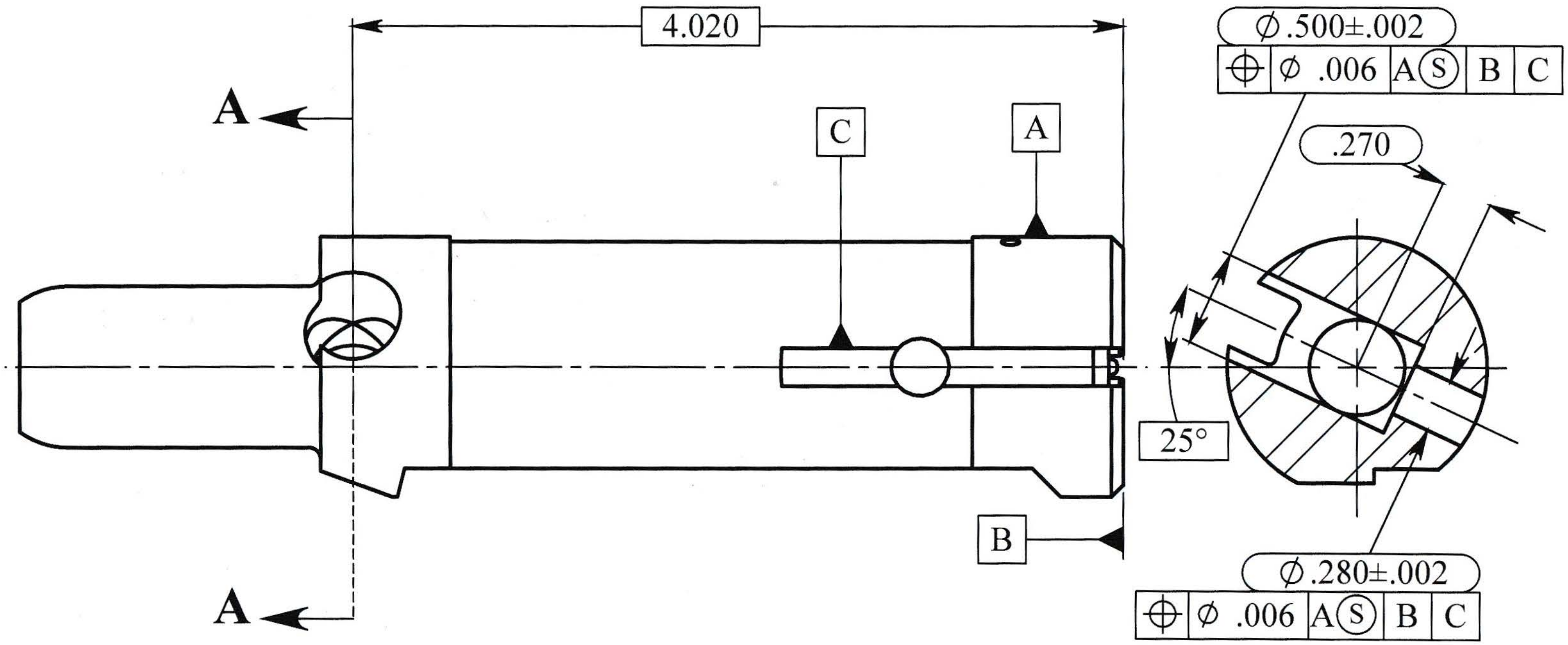
Proprietary and Confidential



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Shell Clearance
	Proprietary and Confidential	FINISH	OPERATION NO. 60 — SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 4140 Ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Breech Bolt OPERATION NAME Disconnector Clearance OPERATION NO. 70 SCALE 1:1



SECTION A-A
SCALE 1 : 1

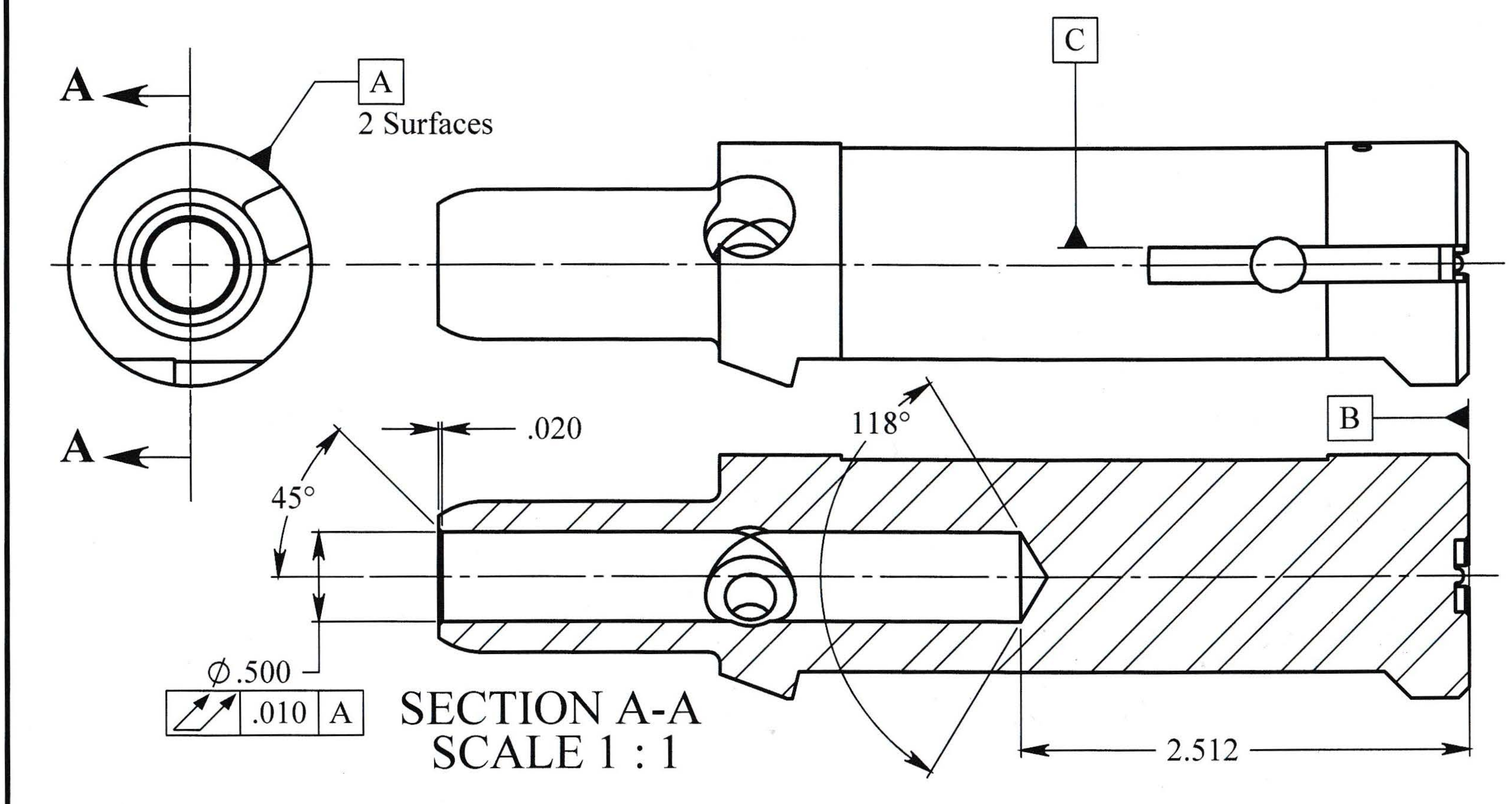
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL: AISI 4140 Ref.	STEN MK II
HEAT TREAT:	PART NAME: Breech Bolt
HARDNESS:	OPERATION NAME: Cocking Handle Hole
FINISH:	OPERATION NO.: 80 / SCALE: 1:1



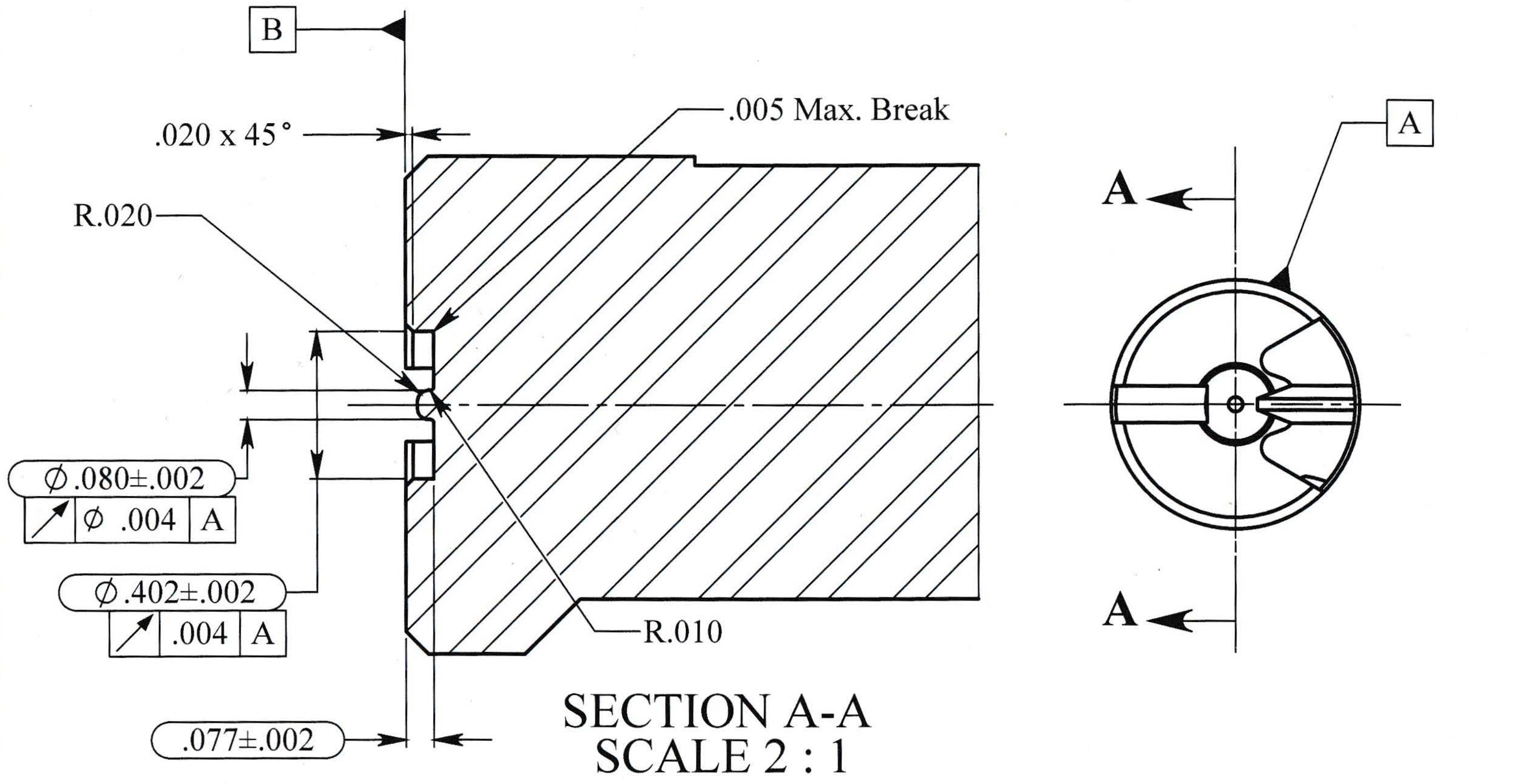
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL AISI 4140 Ref.	STEN MK II
HEAT TREAT	PART NAME Breech Bolt
HARDNESS	OPERATION NAME Lightening Hole
FINISH	OPERATION NO. 90 / SCALE 1:1



SECTION A-A
SCALE 2 : 1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

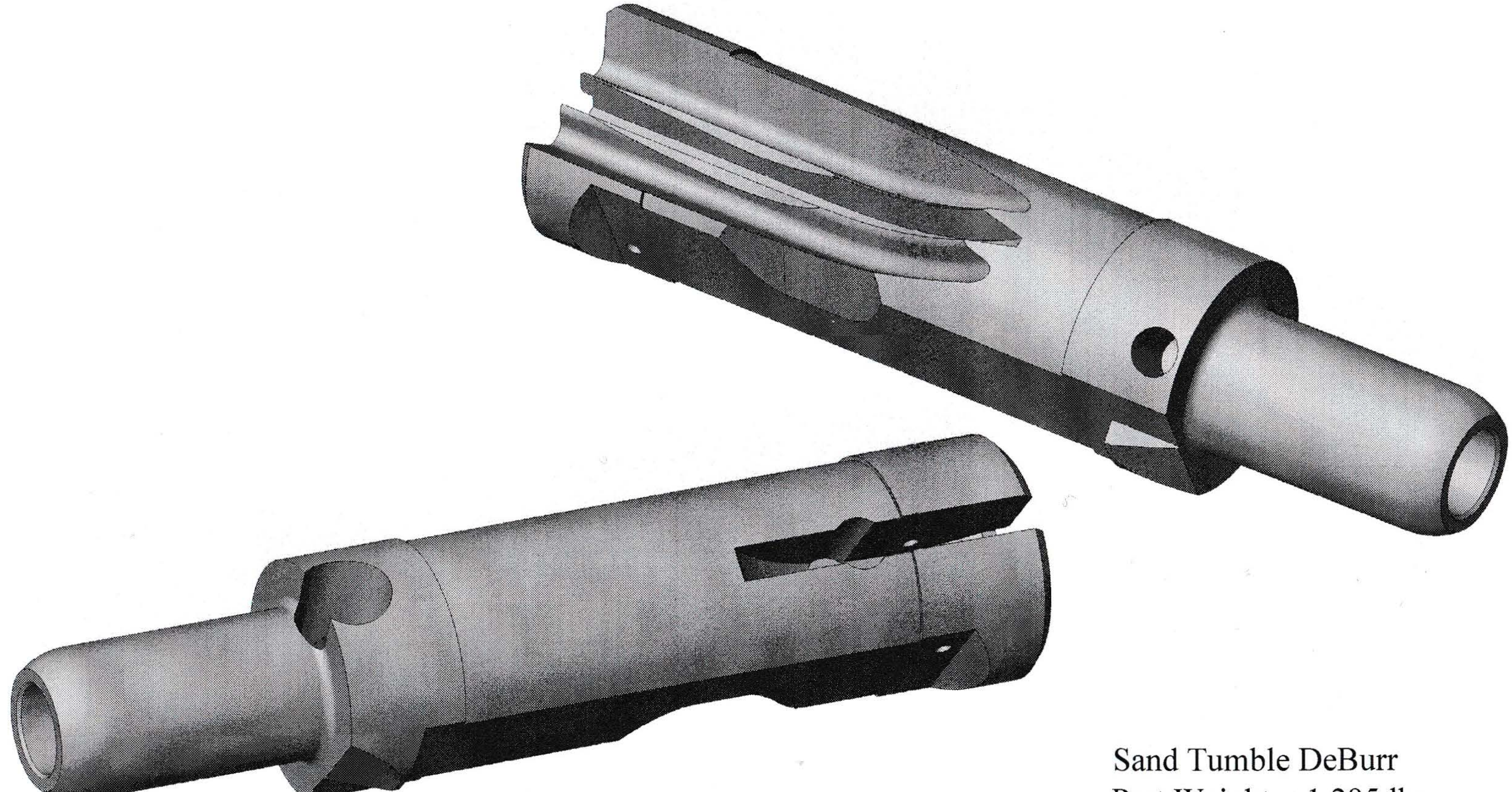
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL	AISI 4140 Ref.
HEAT TREAT	
HARDNESS	
FINISH	

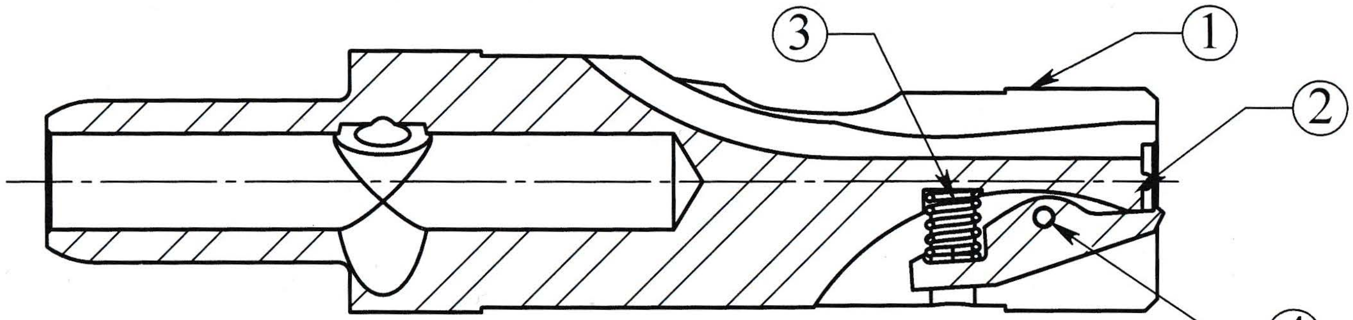
STEN MK II

PART NAME	Breech Bolt
OPERATION NAME	Headspace
OPERATION NO.	100
SCALE	1:1



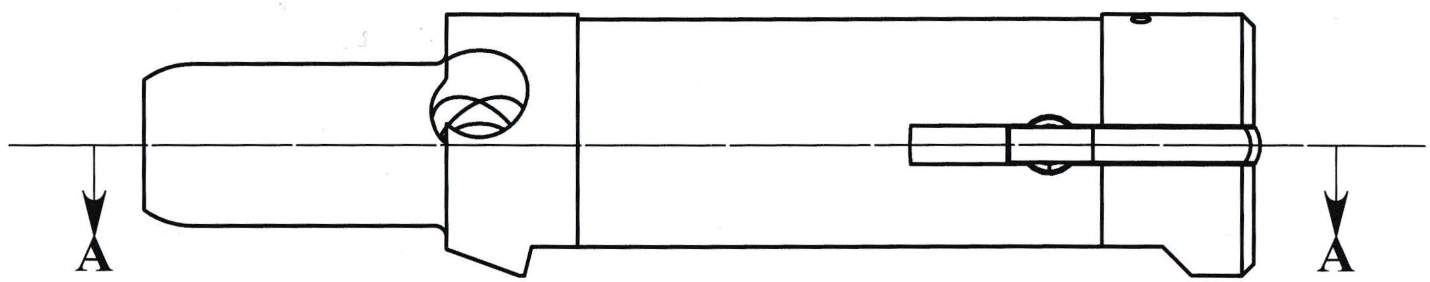
Sand Tumble DeBurr
Part Weight = 1.295 lbs.

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT Austemper	PART NAME Breech Bolt
		HARDNESS HRC 48 - 52	OPERATION NAME Heat Treat & Finish
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 110 — SCALE 1:1



SECTION A-A
SCALE 1 : 1

ITEM NO.	PART NUMBER	QTY.
1	Bolt	1
2	Extractor	1
3	Extractor Spring	1
4	Extractor Pivot Pin	1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

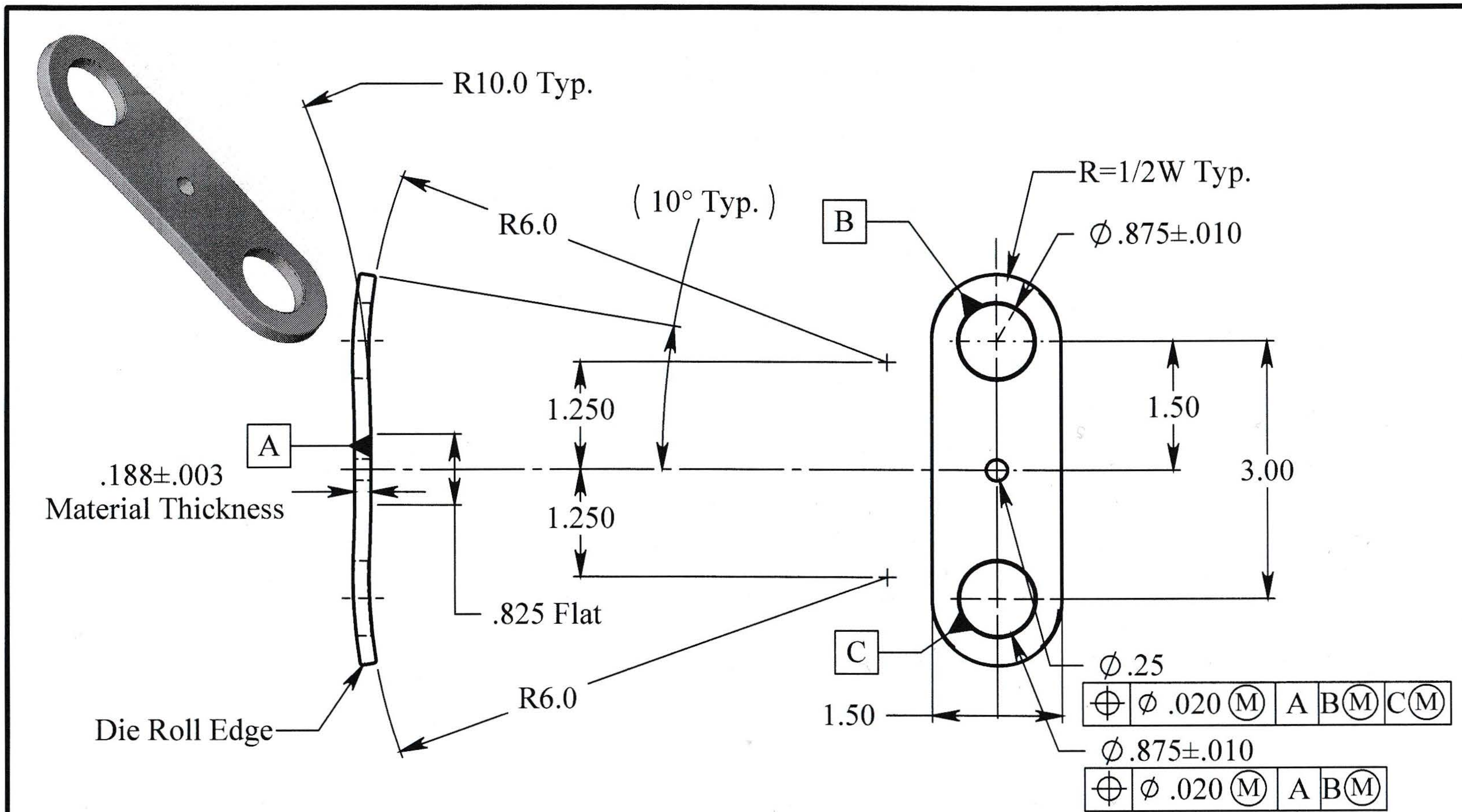
STEN MK II

PART NAME Bolt Assembly

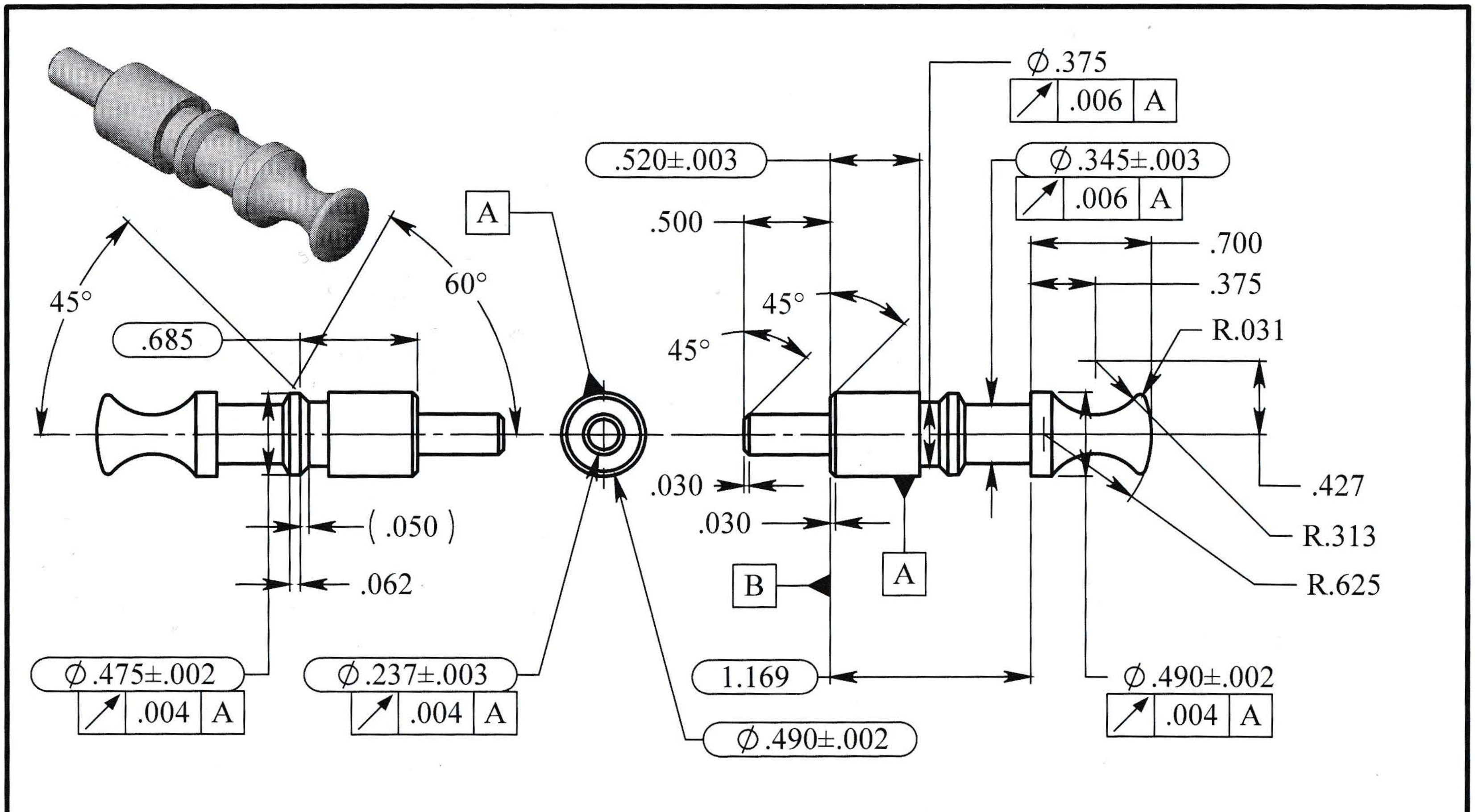
OPERATION NAME

OPERATION NO.

SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT None	PART NAME Butt Plate
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 1:2



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

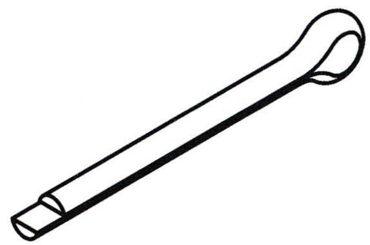
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

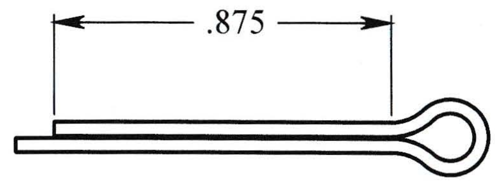
Proprietary and Confidential

MATERIAL	AISI 1118
HEAT TREAT	Carburize .7C .008 Min. Case
HARDNESS	HR15N 88 - 92 HRC 25 Min.
FINISH	Black Oxide

STEN MK II

PART NAME	Cocking Handle
OPERATION NAME	
OPERATION NO.	
SCALE	1:1





American National Standard Cotter Pin
Extended Prong Square Cut Type
3/32 x .875
ANSI B 18.8.1 - 1972

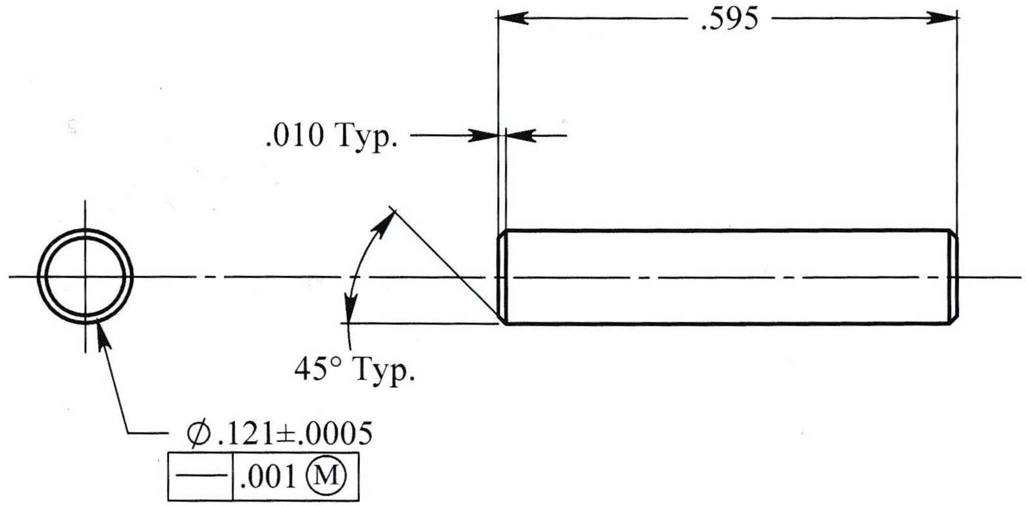
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL Steel	STEN MK II
HEAT TREAT	PART NAME Cotter Pin (2 Required)
HARDNESS	OPERATION NAME
FINISH Zinc Plated	OPERATION NO. / SCALE 2:1



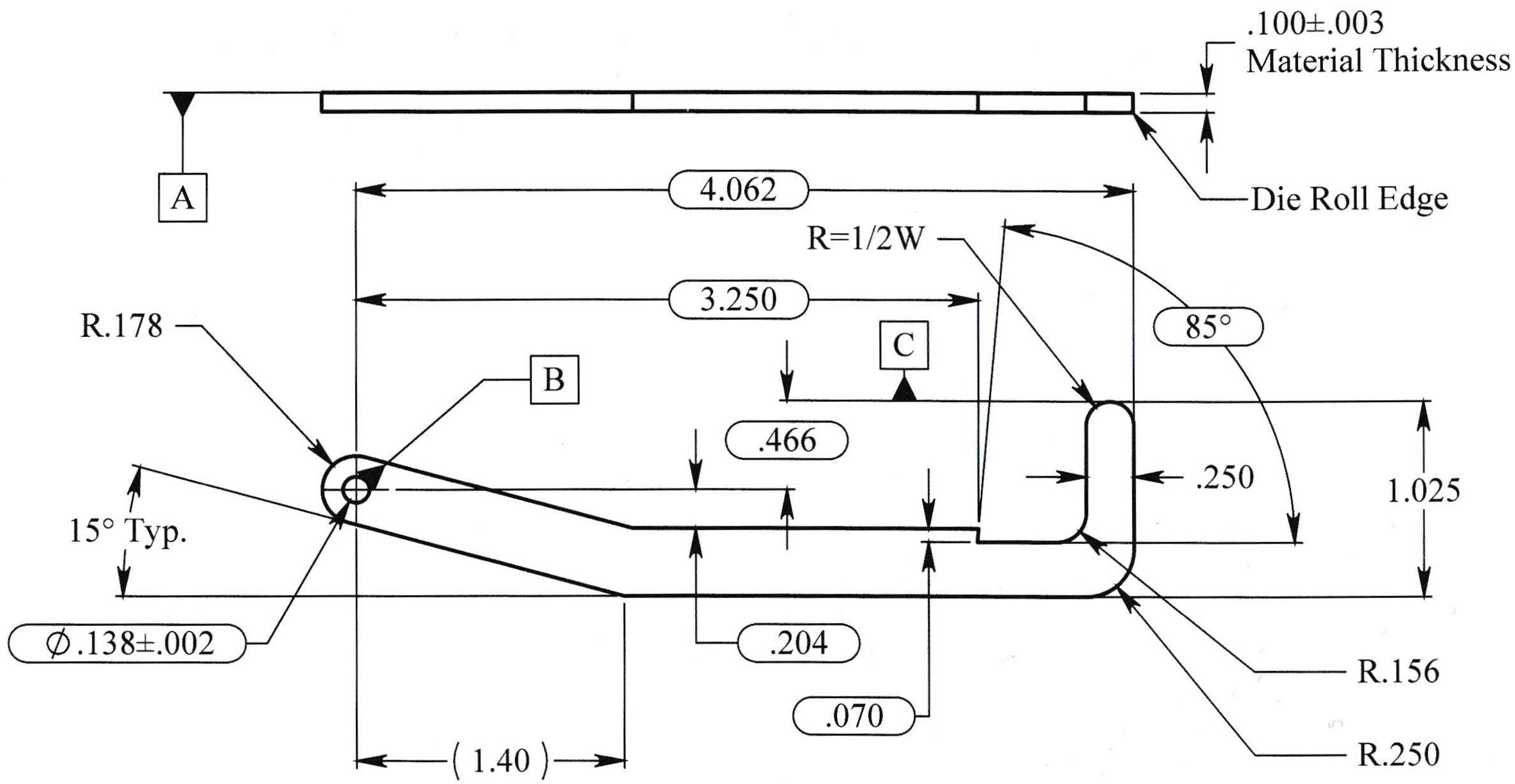
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

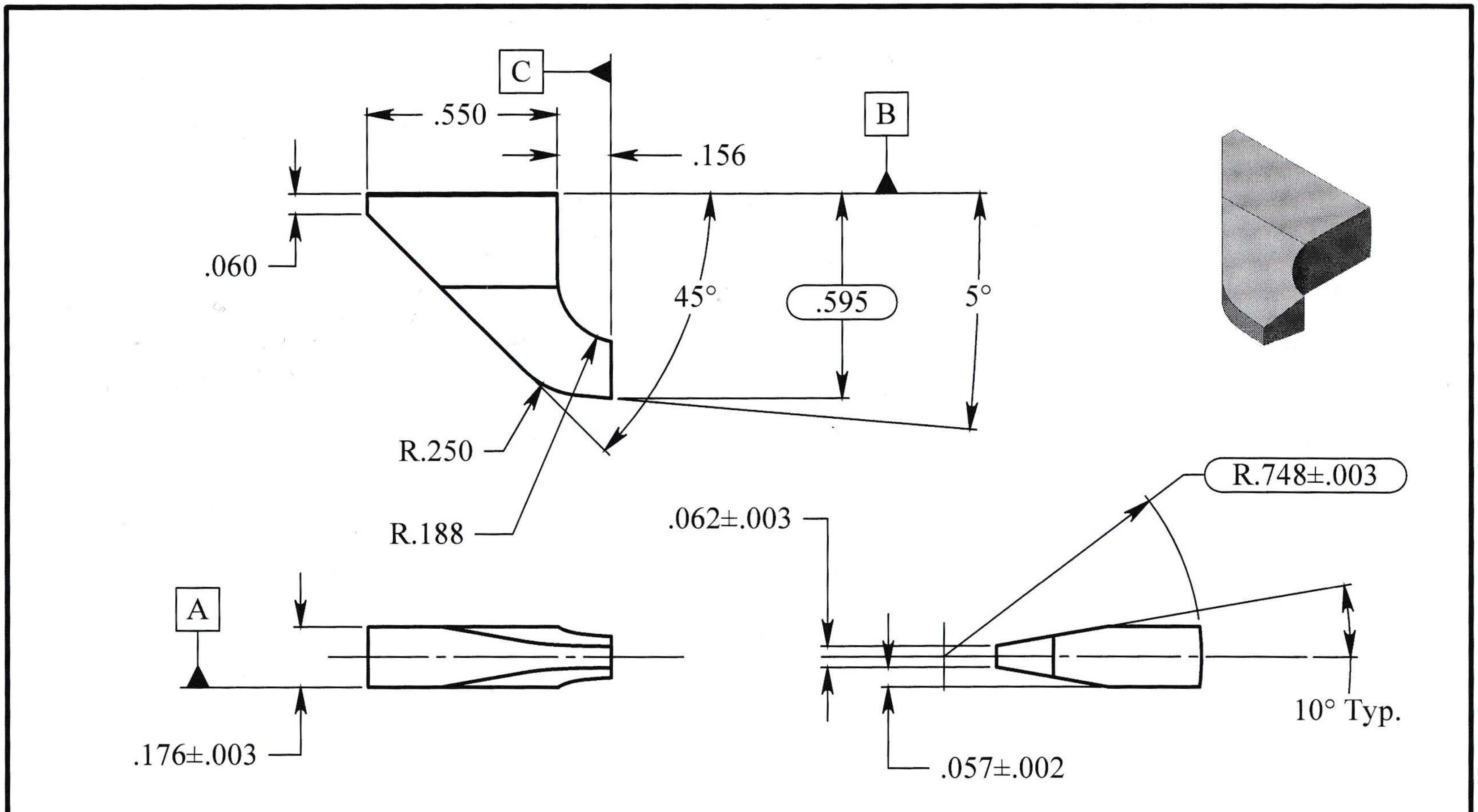
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1095	STEN MK II
HEAT TREAT Neutral Salt Harden	PART NAME Disconnector Pivot Pin
HARDNESS HRC 48 - 53	OPERATION NAME
FINISH Black Oxide	OPERATION NO. / SCALE 4:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1070 HEAT TREAT Neutral Salt Harden HARDNESS HRC 45 - 50 FINISH Black Oxide	STEN MK II PART NAME Disconnector OPERATION NAME OPERATION NO. SCALE 1:1
	Proprietary and Confidential		



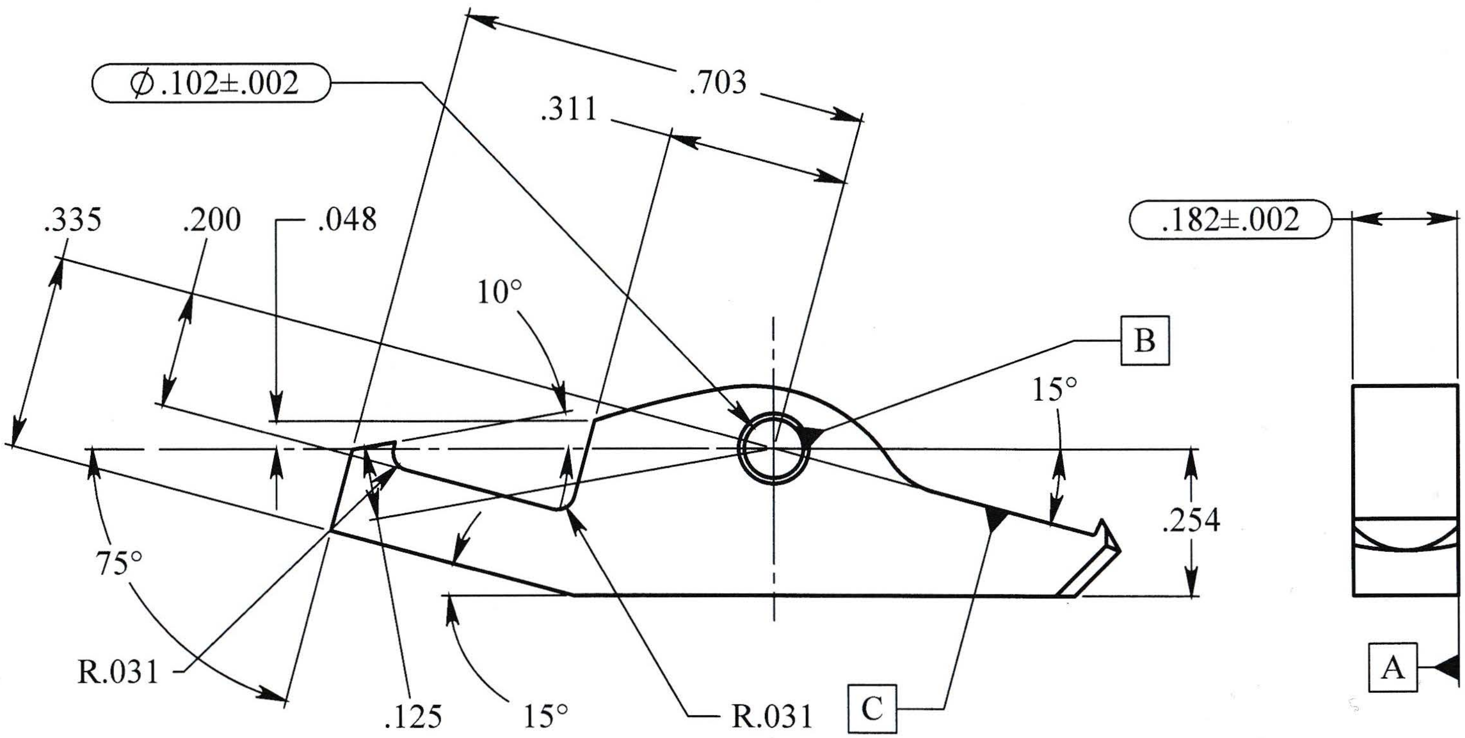
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

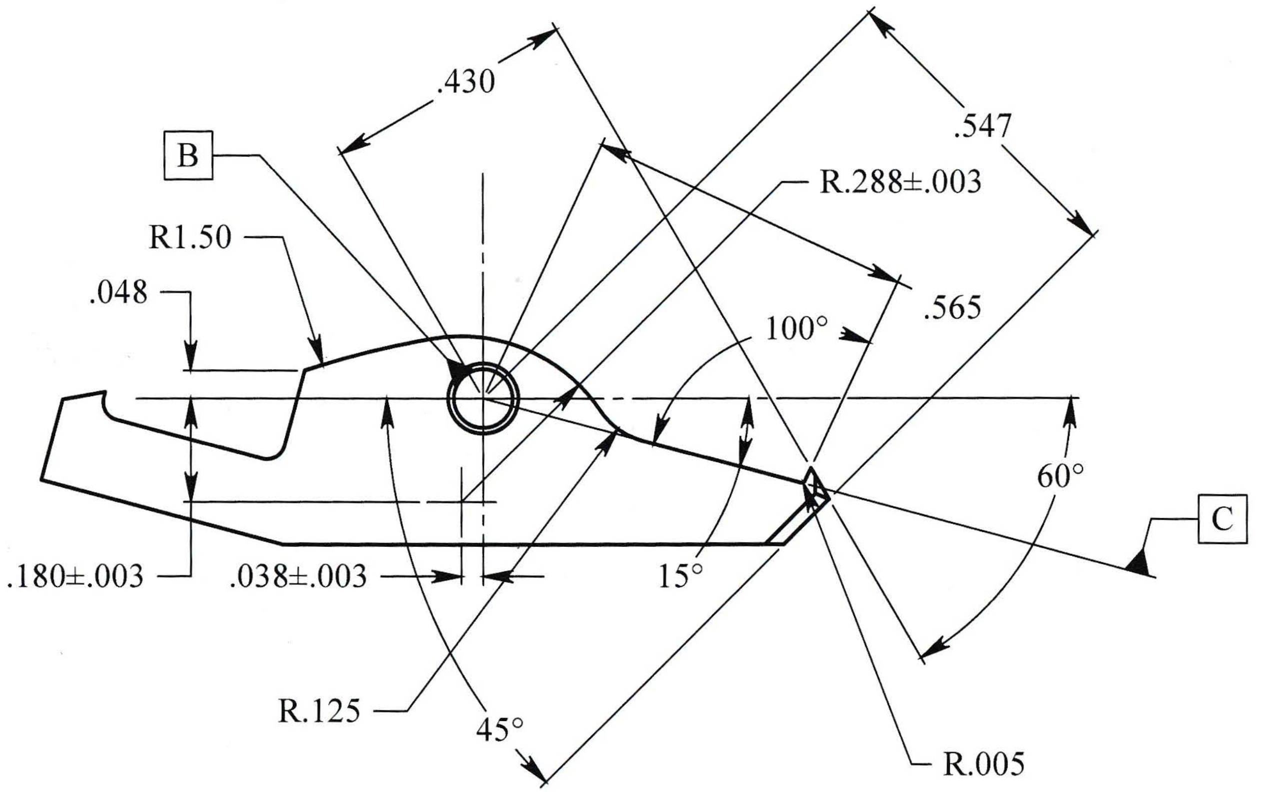
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT	PART NAME Ejector
HARDNESS	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	STEN MK II	
		HEAT TREAT	PART NAME Extractor Profile	
		HARDNESS	OPERATION NAME 10	
	Proprietary and Confidential	FINISH	OPERATION NO.	SCALE 3:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL: AISI 4140

HEAT TREAT:

HARDNESS:

FINISH:

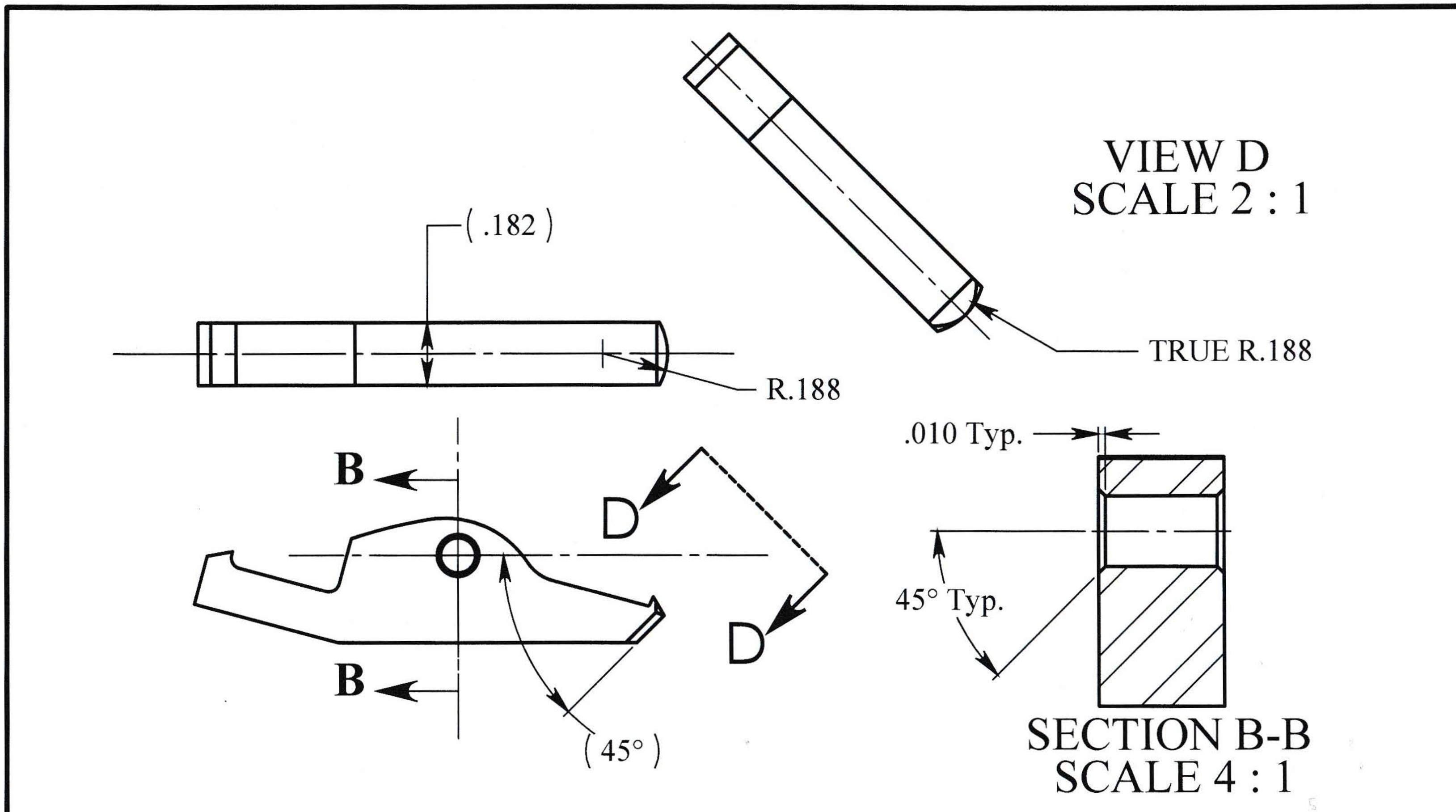
STEN MK II

PART NAME: Extractor Profile

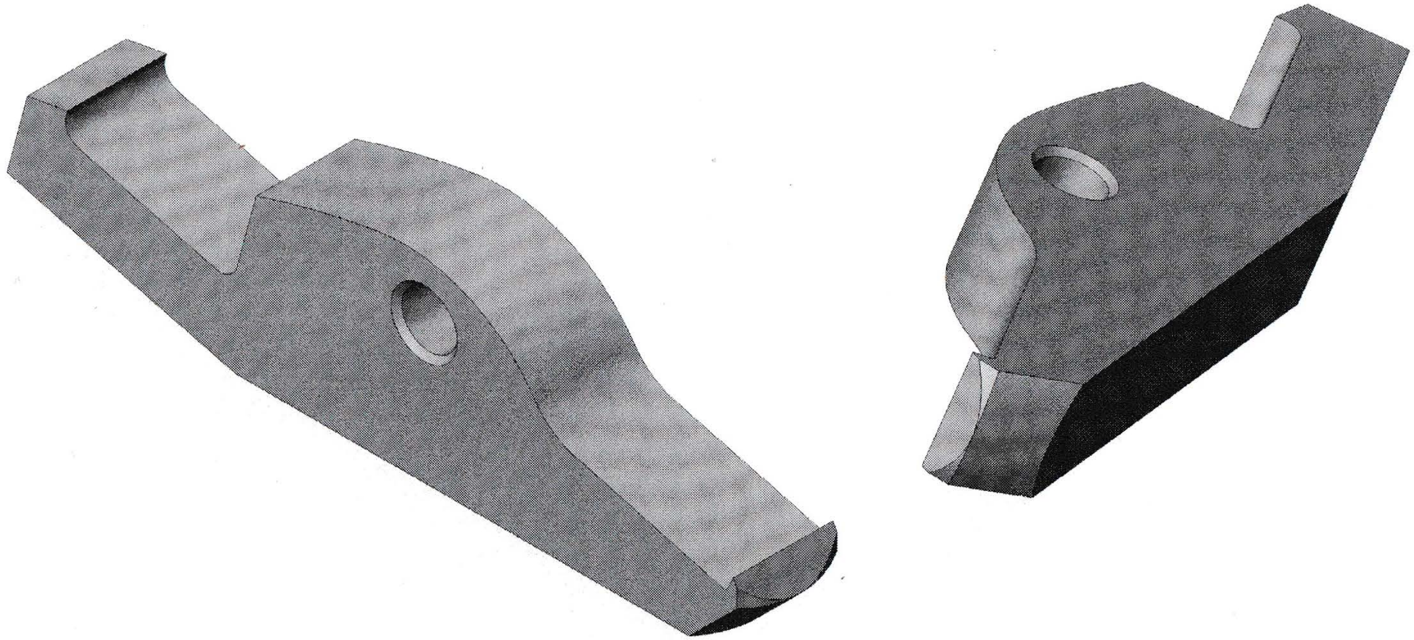
OPERATION NAME: 20

OPERATION NO.:

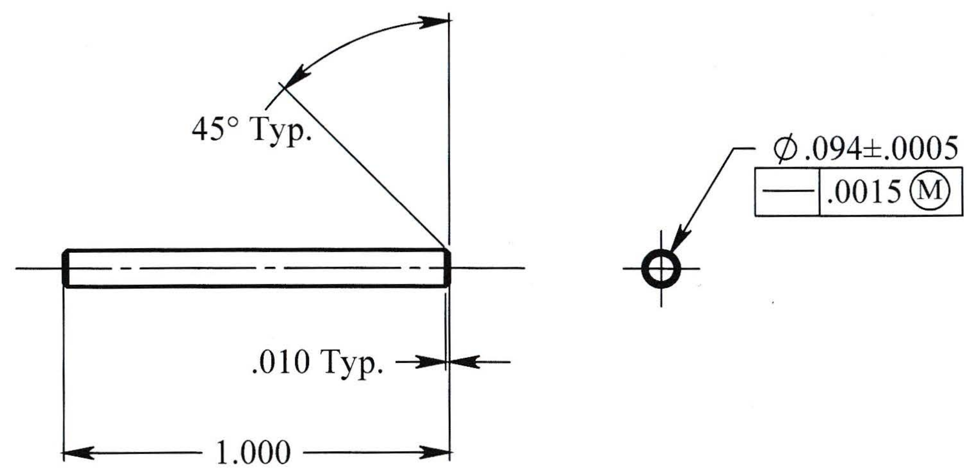
SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT	PART NAME Extractor
		HARDNESS	OPERATION NAME Extractor Machining
	Proprietary and Confidential	FINISH	OPERATION NO. 30 — SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT Quench &Temper	PART NAME Extractor
		HARDNESS HRC 40 - 45	OPERATION NAME Finish and Heat Treat
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 40 — SCALE 4:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1095	STEN MK II
HEAT TREAT Neutral Salt Harden	PART NAME Extractor Pivot Pin
HARDNESS HRC 48-53	OPERATION NAME
FINISH Black Oxide	OPERATION NO. / SCALE 2:1

Manufacturing Data:

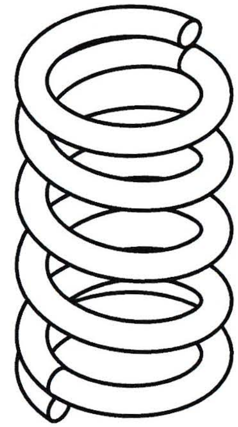
Spring Type:	Helical Compression
Outside Diameter:	.280 inches
Wire Diameter:	.039
Total Coils:	5.5
Active Coils:	3.5
Coil Type:	Closed, Not Ground
Free Length:	.472
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.375 inches
Load P1:	6.5 +/-1.5 lbs.
Load Length L2:	.265 inches
Load P2:	13.9 +/-. 1.8 lbs.
Max. Solid Height:	.260 inches

Engineering Data:

Spring Rate:	66.9 lbs/in.
Spring Index:	6.2
Static Solid Stress:	188,250 psi
Stress Percentage: at Solid Height	59.2%



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Music Wire (ASTM A228)

STEN MK II

HEAT TREAT: Stress Relieve

PART NAME: Extractor Spring

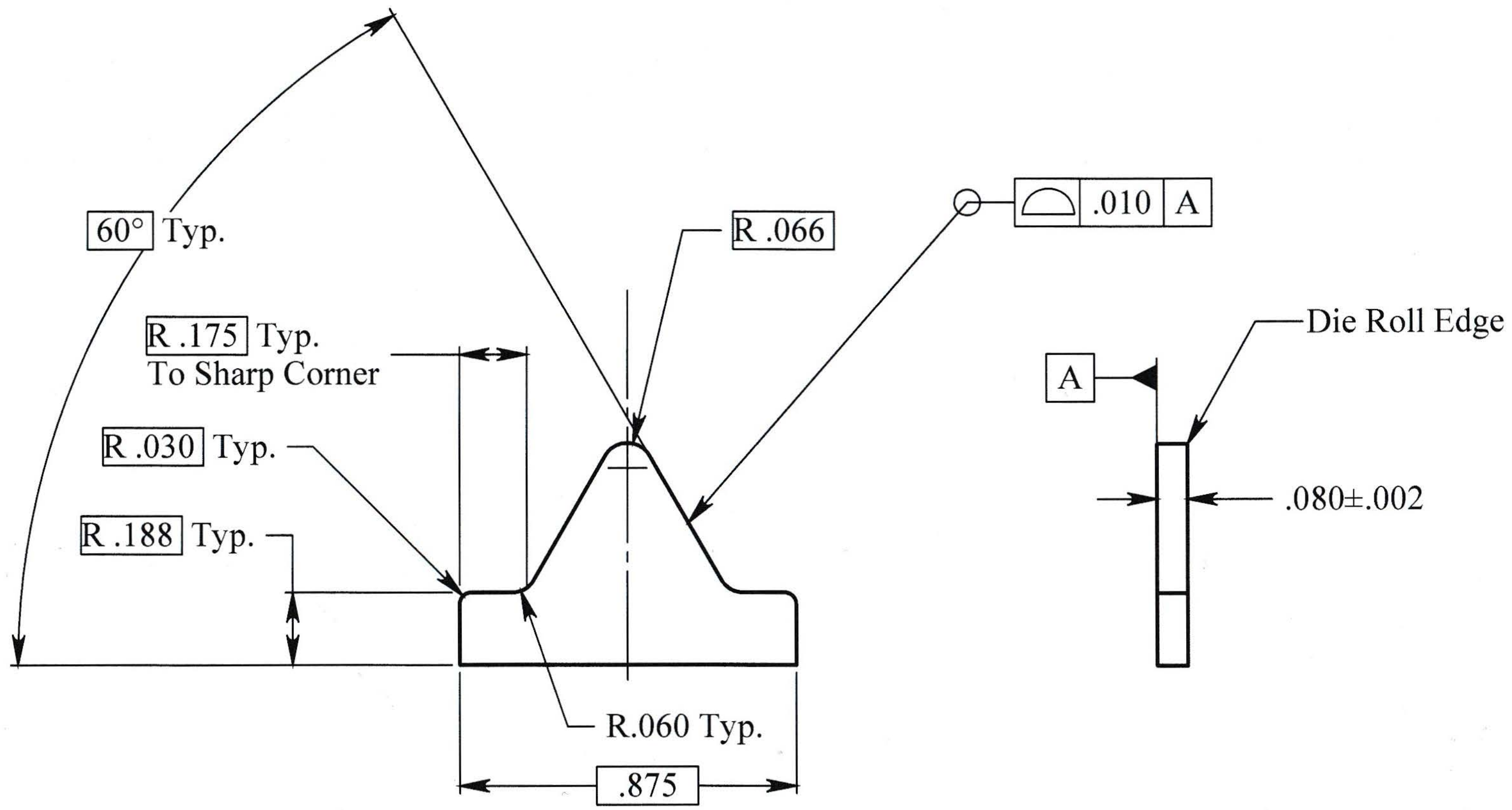
HARDNESS:

OPERATION NAME:

FINISH: Oiled

OPERATION NO.:

SCALE: 4:1



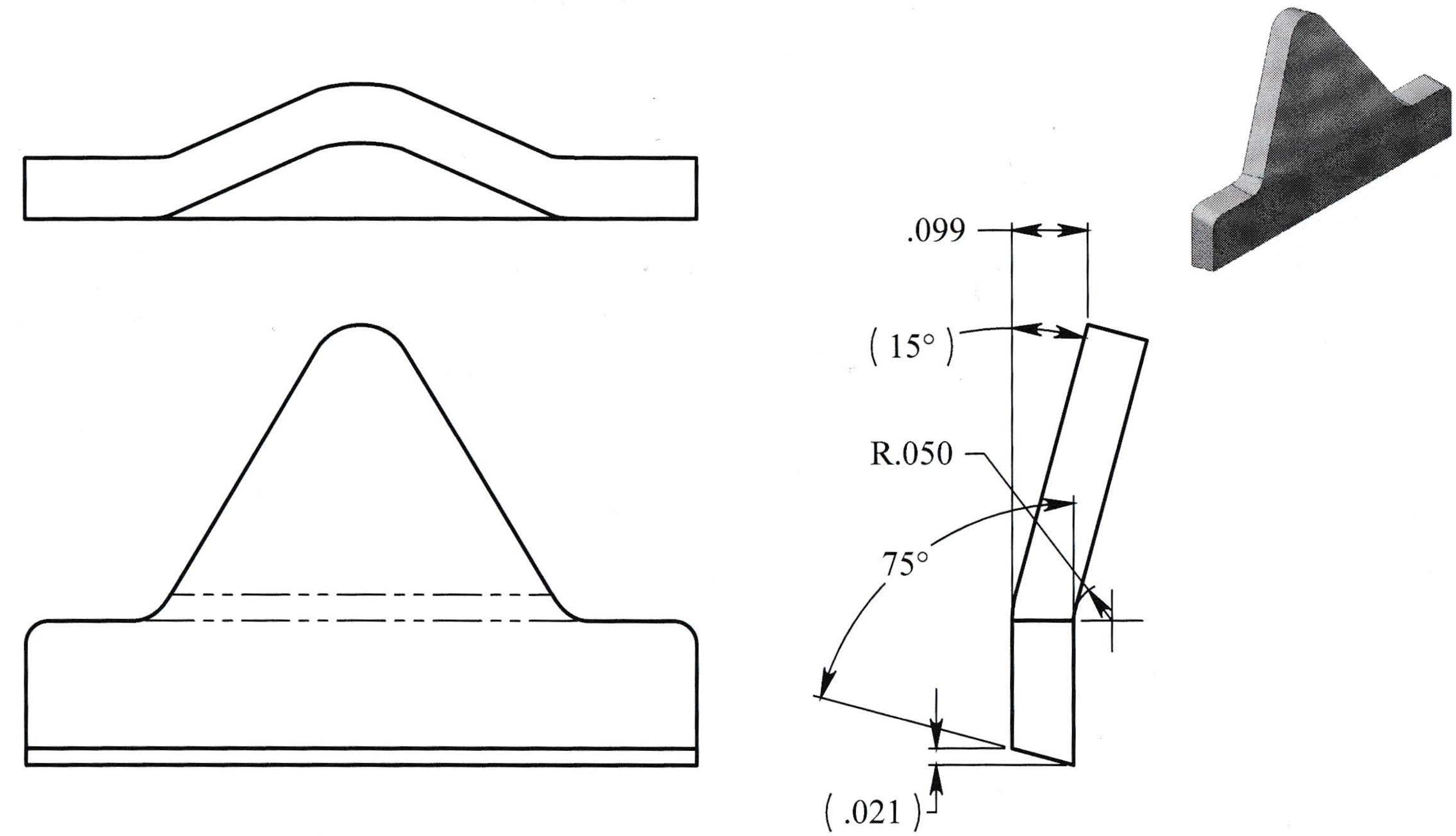
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Front Sight
HARDNESS HRB 100 Min.	OPERATION NAME Flat Pattern
FINISH None	OPERATION NO. 10 — SCALE 2:1



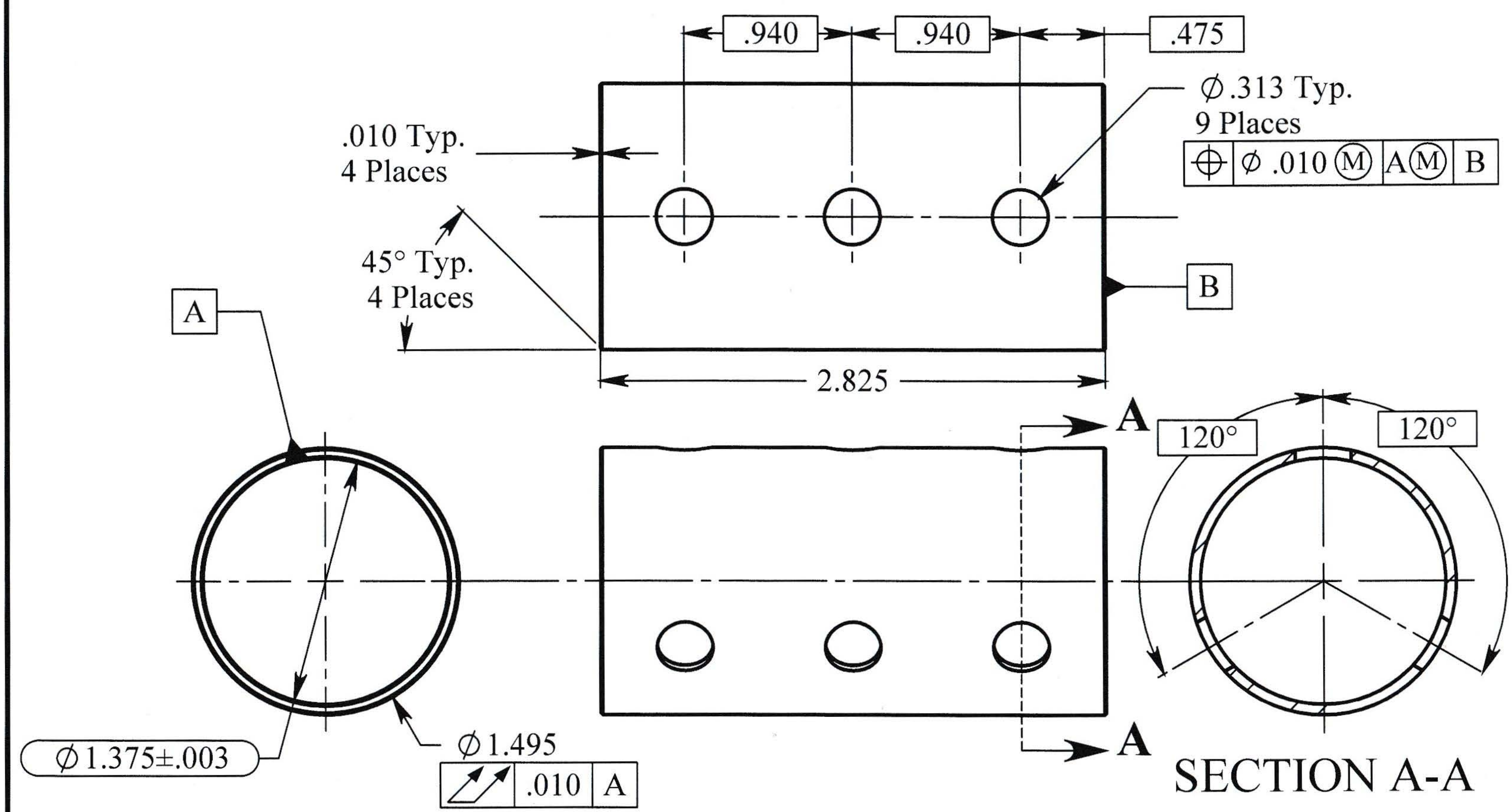
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

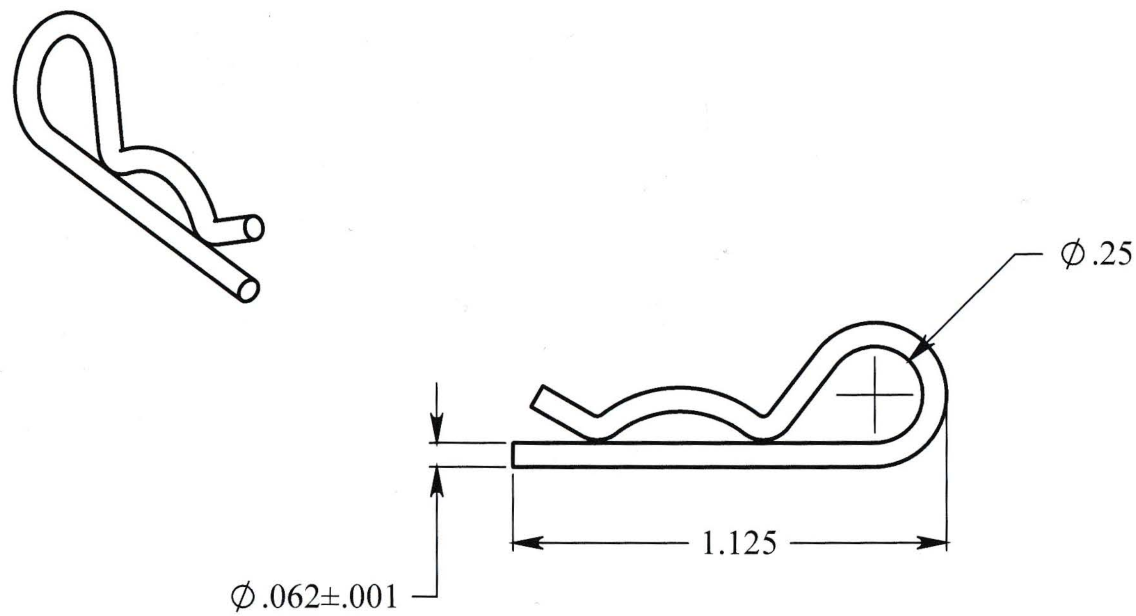
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance →| |← (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |← (C .XXX)

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Front Sight
HARDNESS HRB 100 Min.	OPERATION NAME Forming
FINISH None	OPERATION NO. 20 — SCALE 2:1

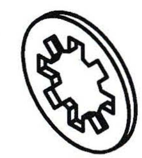


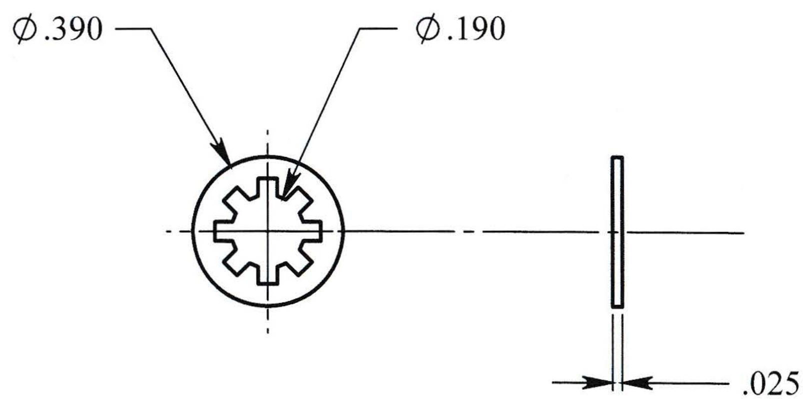
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT None	PART NAME Heat Shield
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 1:2



18-8 Stainless Steel Reusable Hitch/Cotter Pin

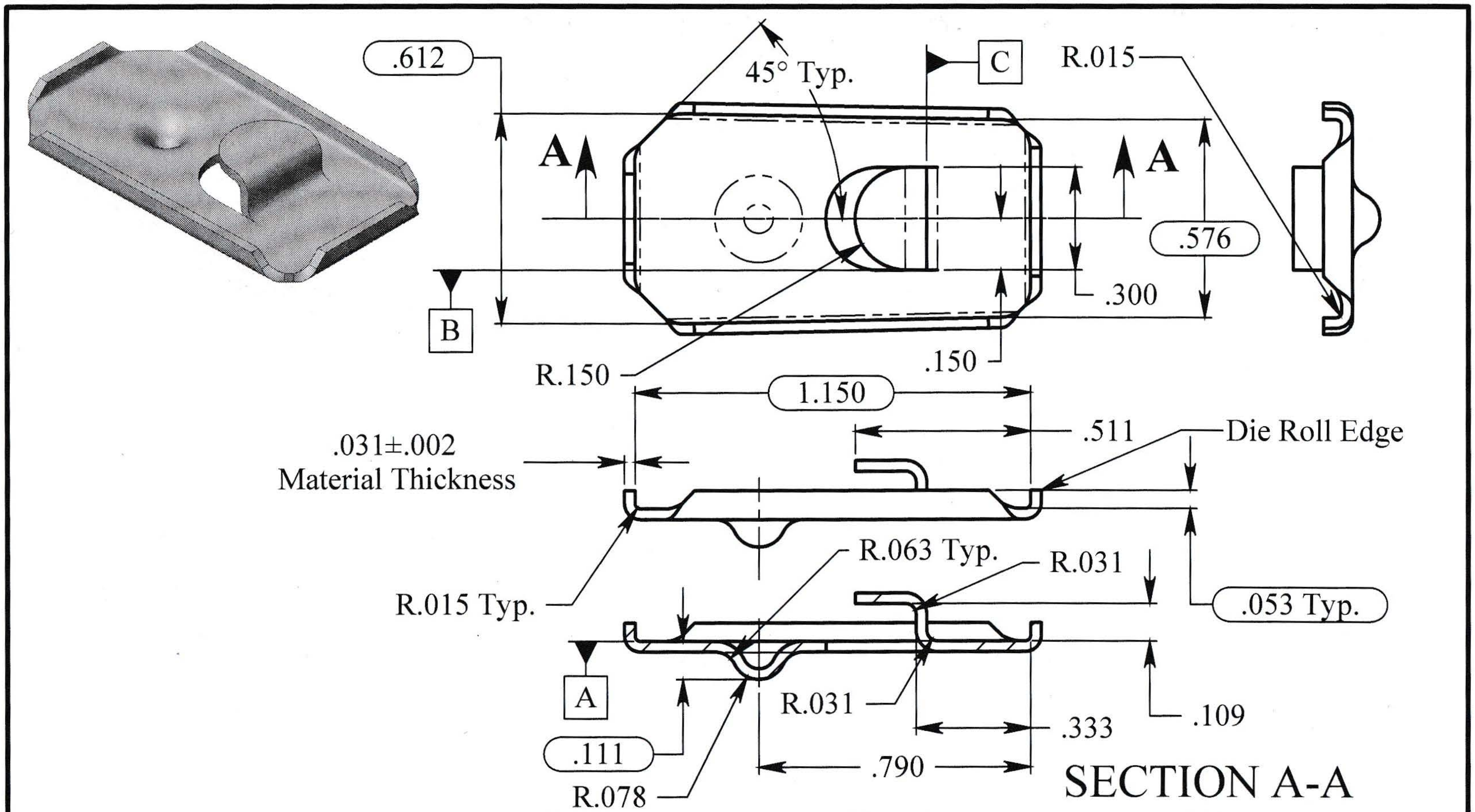
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 18-8 Stainless	STEN MK II
		HEAT TREAT Vendor Spec.	PART NAME Hitch Pin
		HARDNESS Vendor Spec.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 2:1



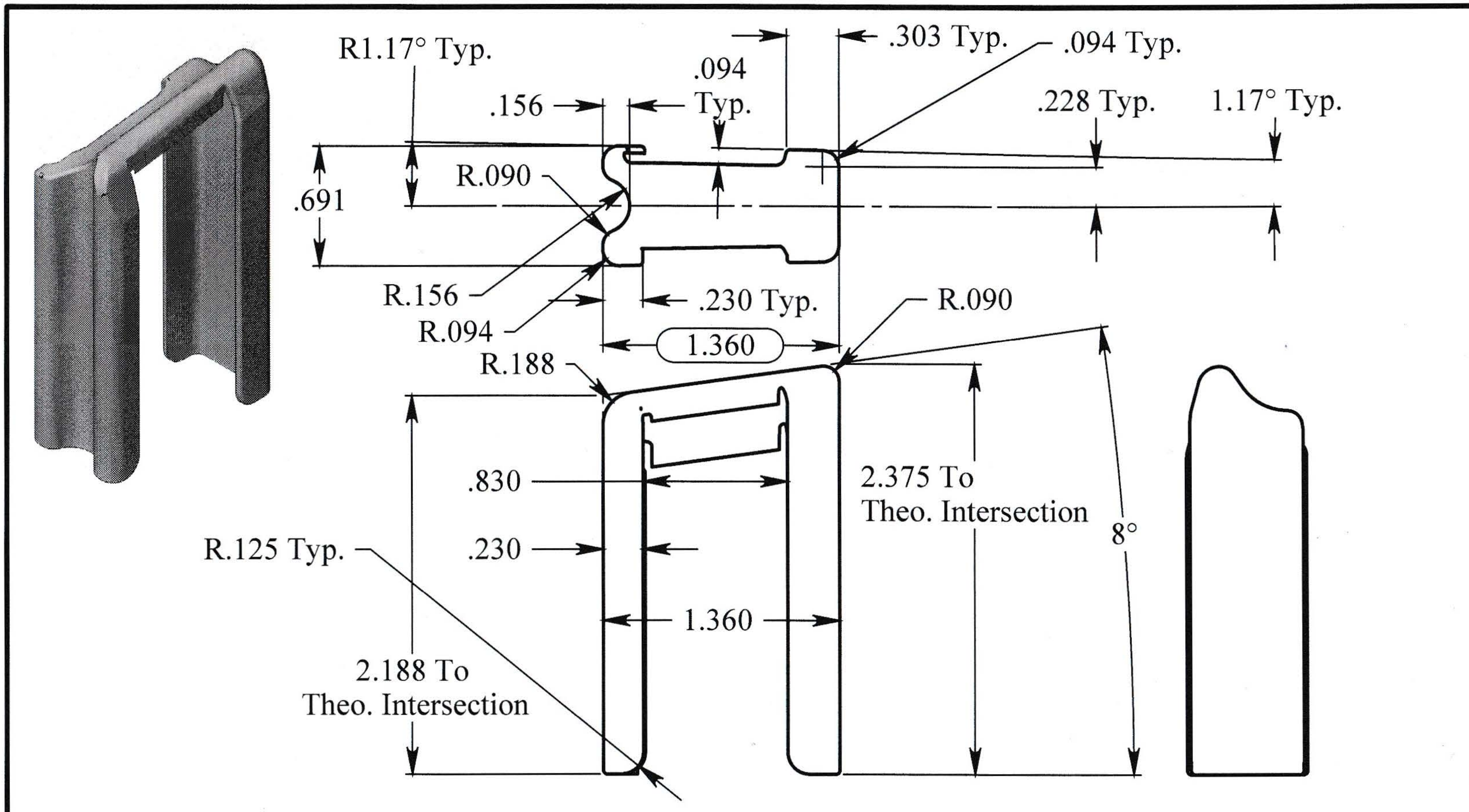


Internal Tooth Lock Washer
For #10 Screw
ANSI B18.21.I-1972

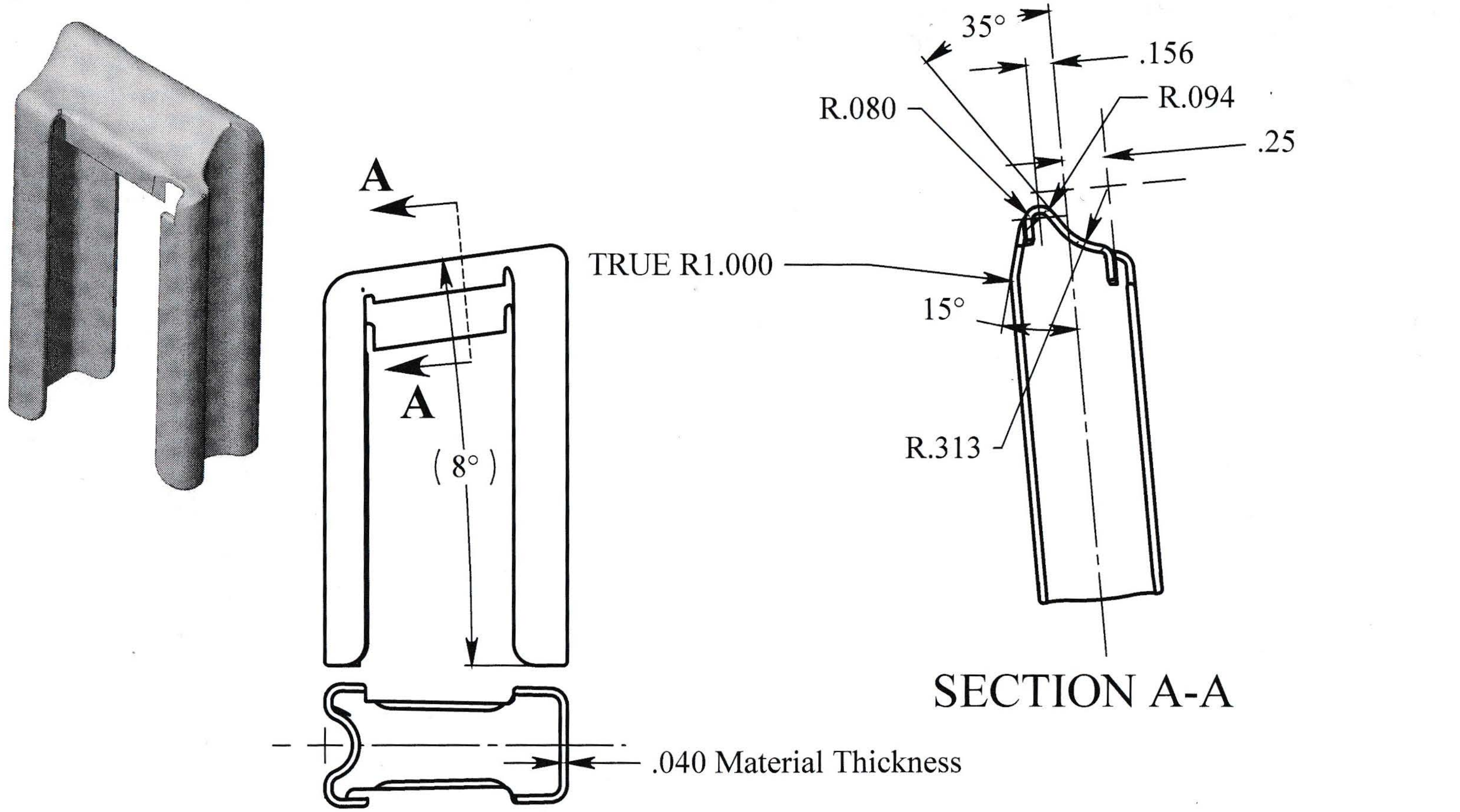
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL Carbon Steel	STEN MK II
		HEAT TREAT Per ANSI Spec.	PART NAME Lock Washer (3 Required)
		HARDNESS Per ANSI Spec.	OPERATION NAME
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. / SCALE 2:1



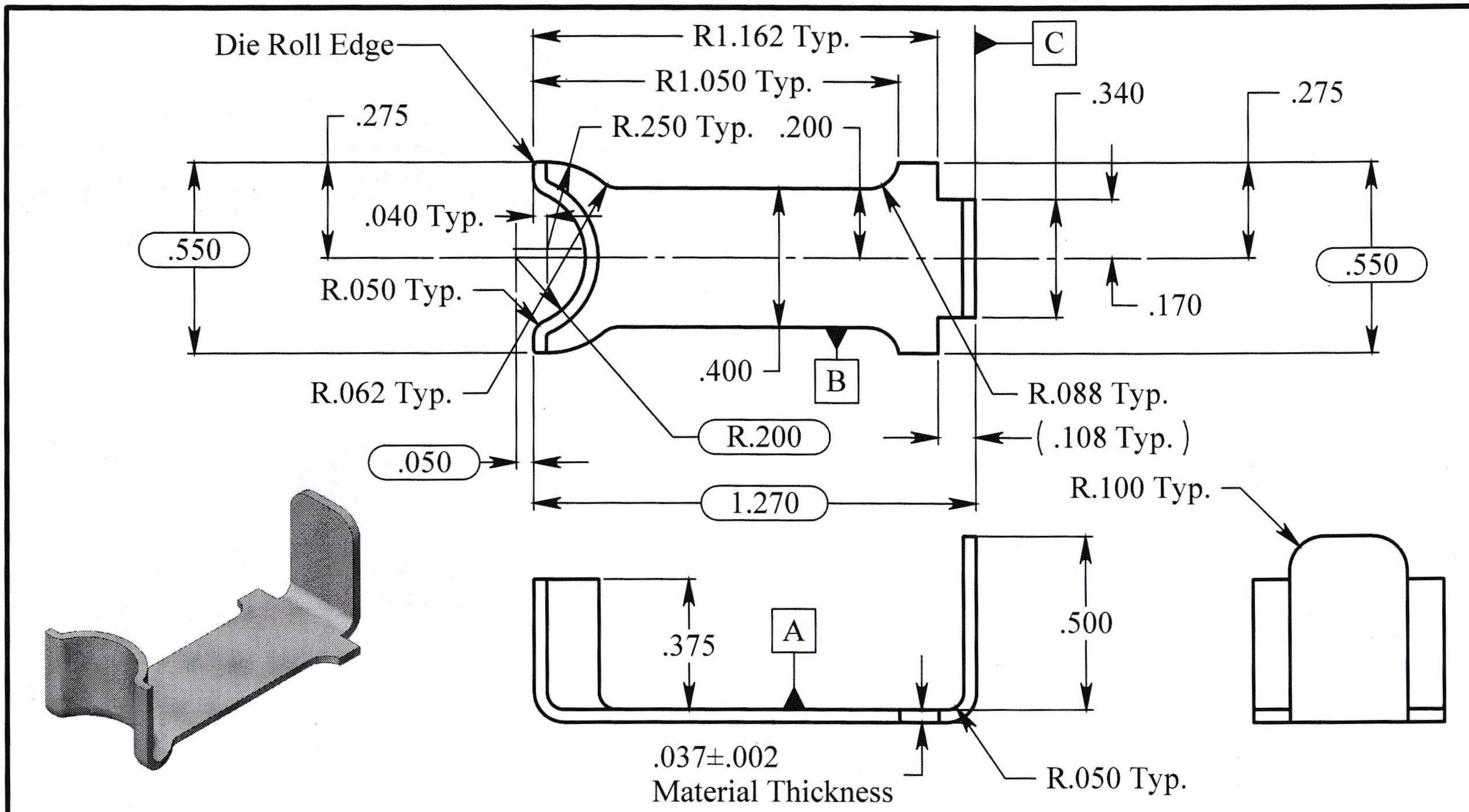
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT	PART NAME Mag. Box Retainer
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. / SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT	PART NAME Magazine Follower
		HARDNESS HRB 100 Min.	OPERATION NAME Outside Profile
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 10 / SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 1010	STEN MK II	
		HEAT TREAT	PART NAME Magazine Follower	
		HARDNESS HRB 100 Min.	OPERATION NAME Lip Profile	
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 20	SCALE 1:1



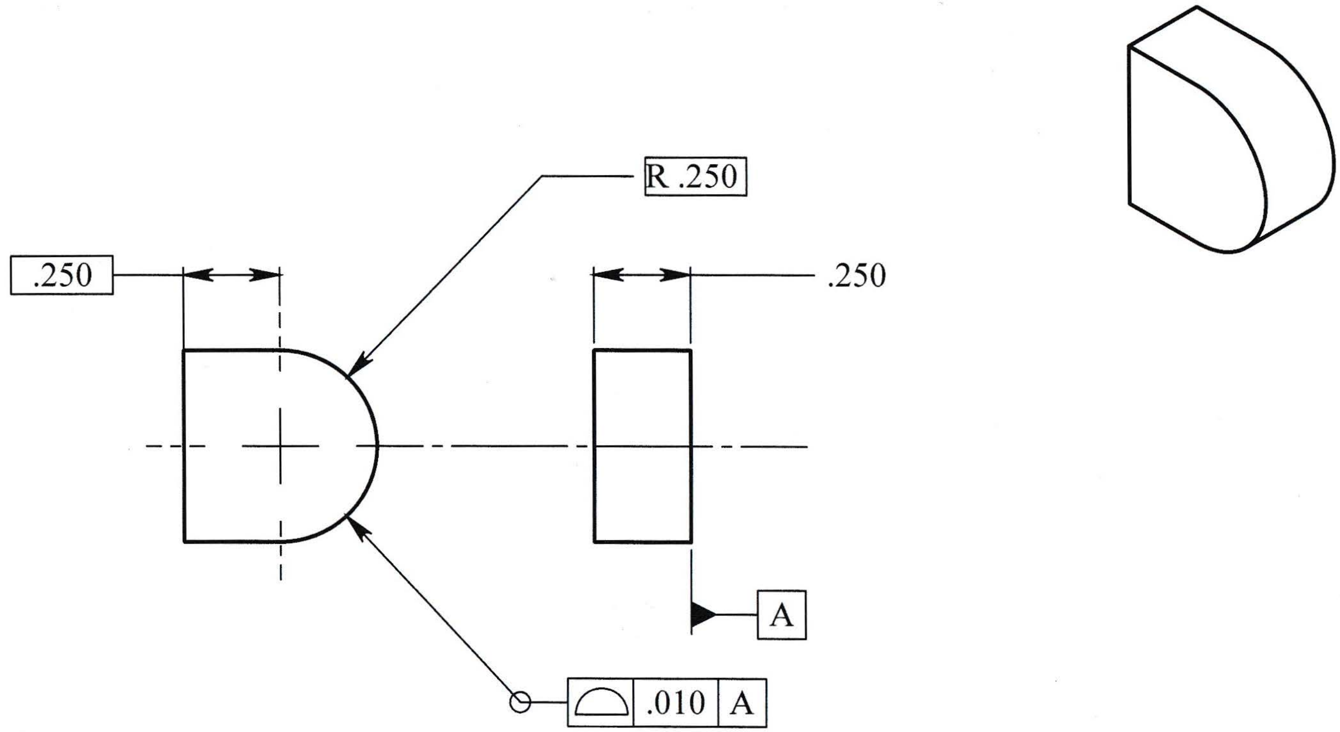
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II
HEAT TREAT	PART NAME Mag. Follower Support
HARDNESS HRB 100 Min.	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 2:1



Dimensions are in Inches

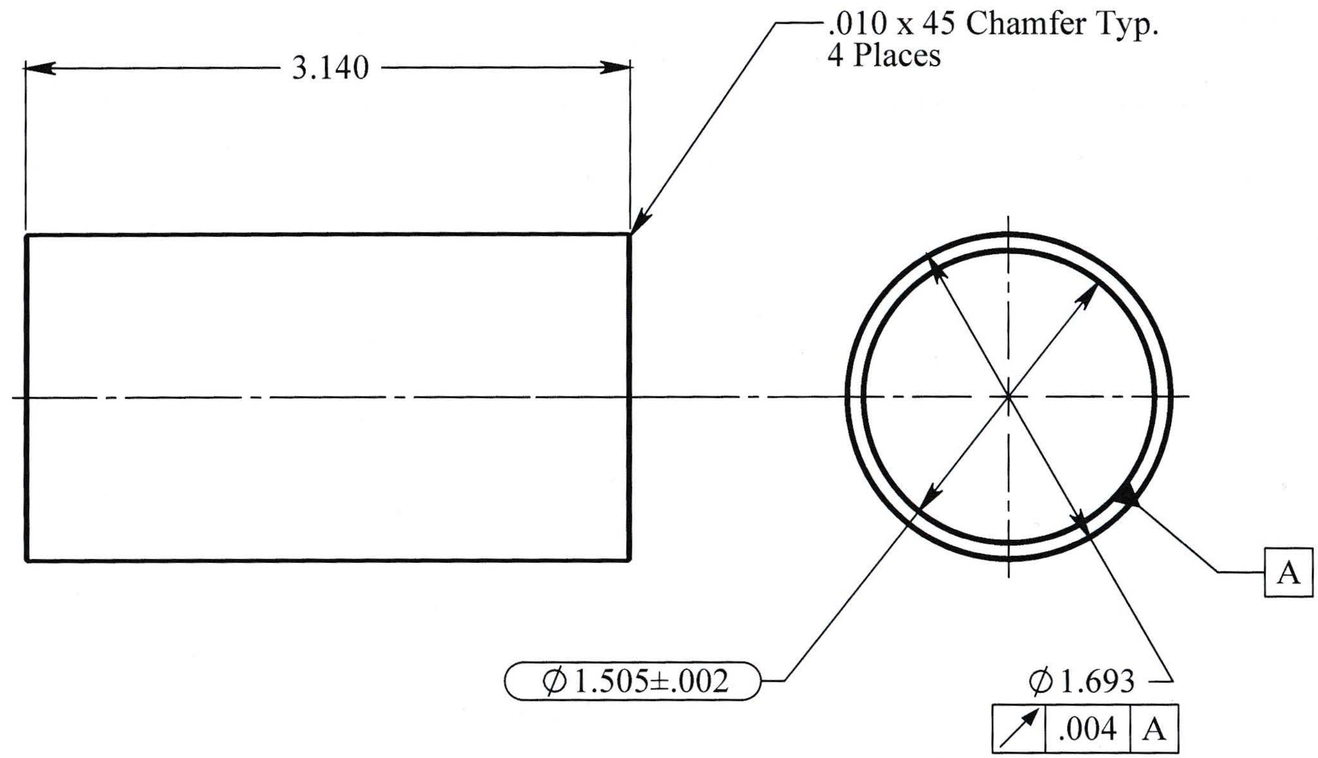
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance →| |←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |←(C .XXX)

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II	
HEAT TREAT None	PART NAME Mag. Latch Stud	
HARDNESS HRB 100 Min.	OPERATION NAME	
FINISH None	OPERATION NO.	SCALE 2:1



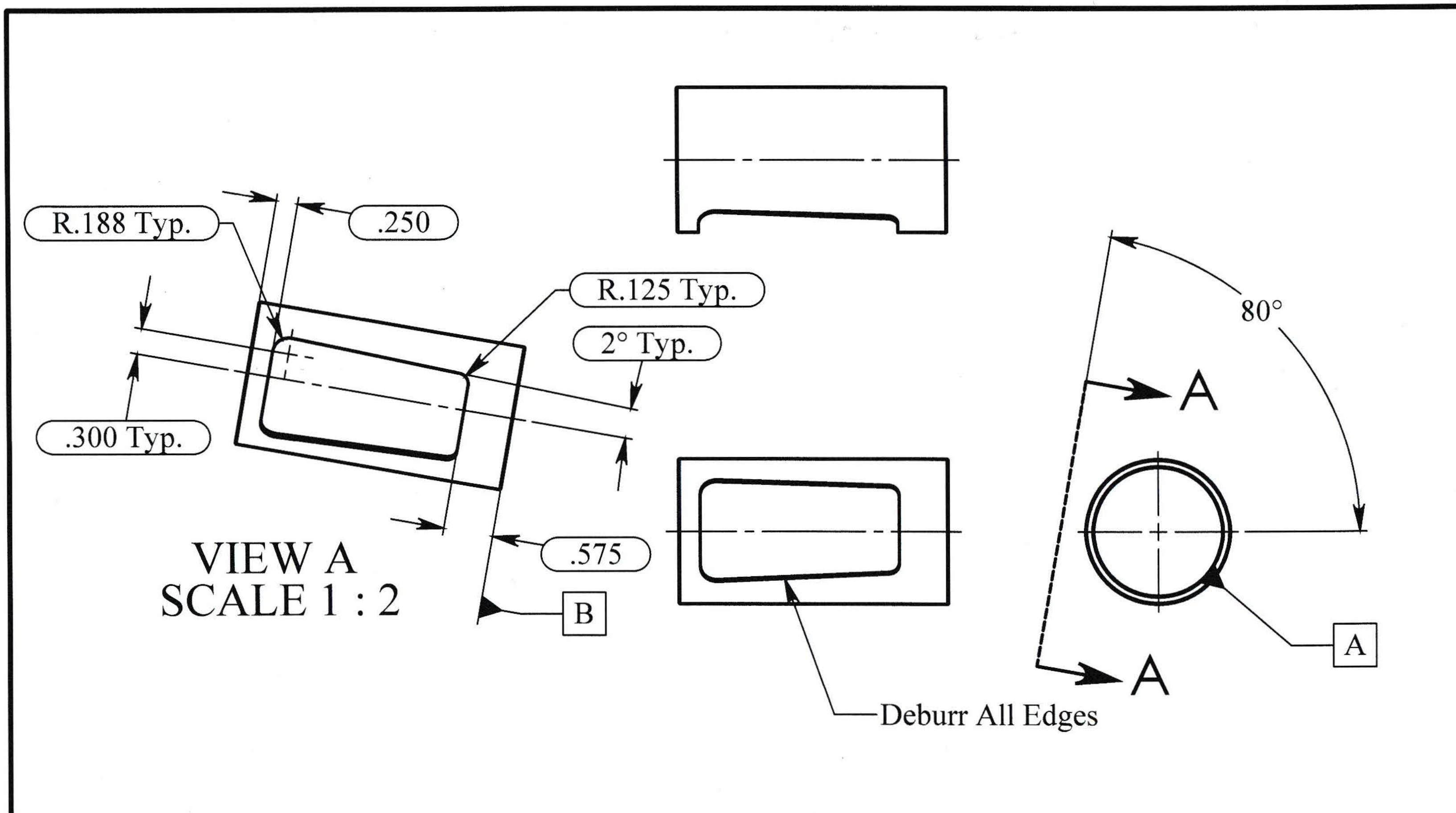
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II
HEAT TREAT None	PART NAME Magazine Housing Tube
HARDNESS None	OPERATION NAME Tube
FINISH None	OPERATION NO. 10 / SCALE 1:1



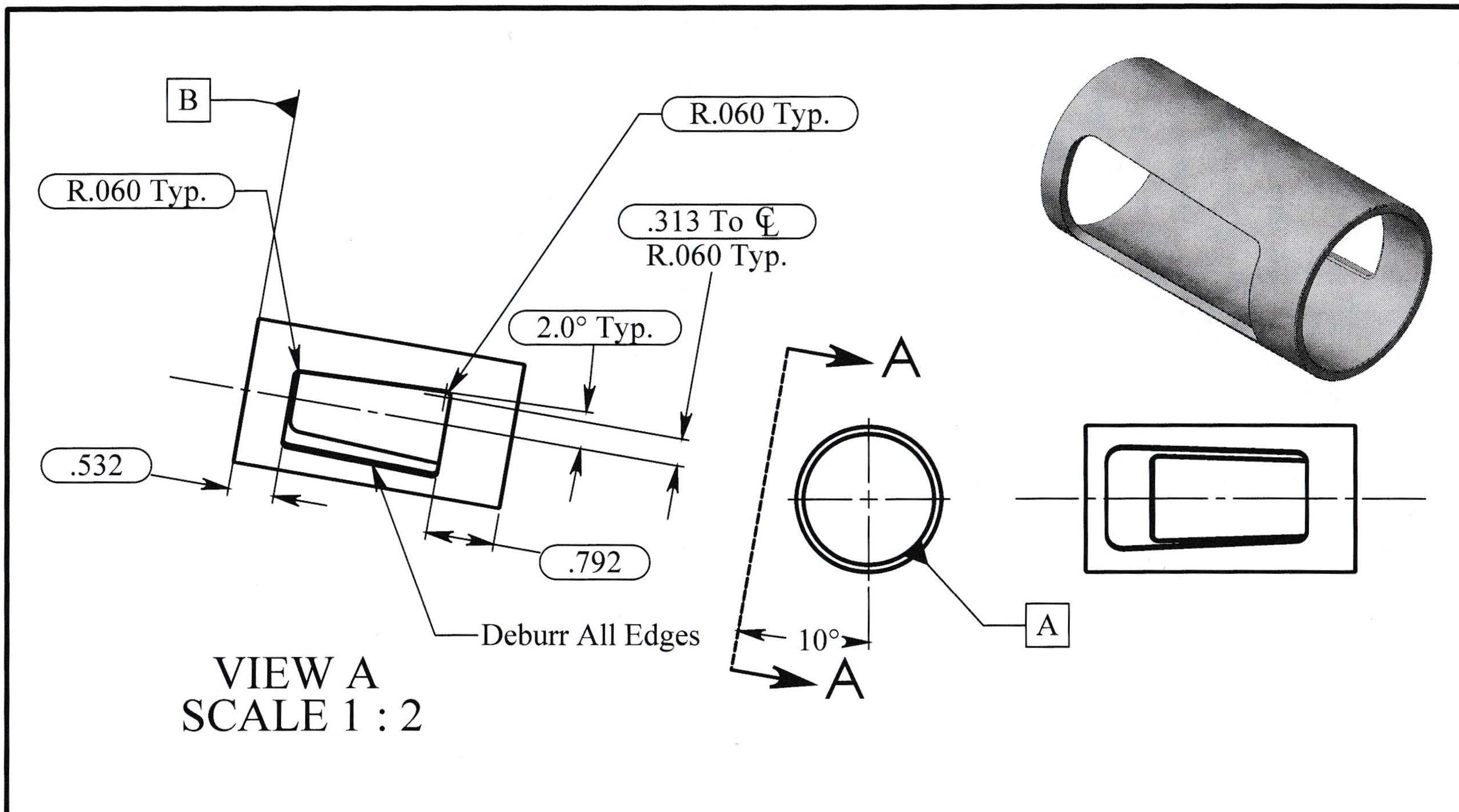
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

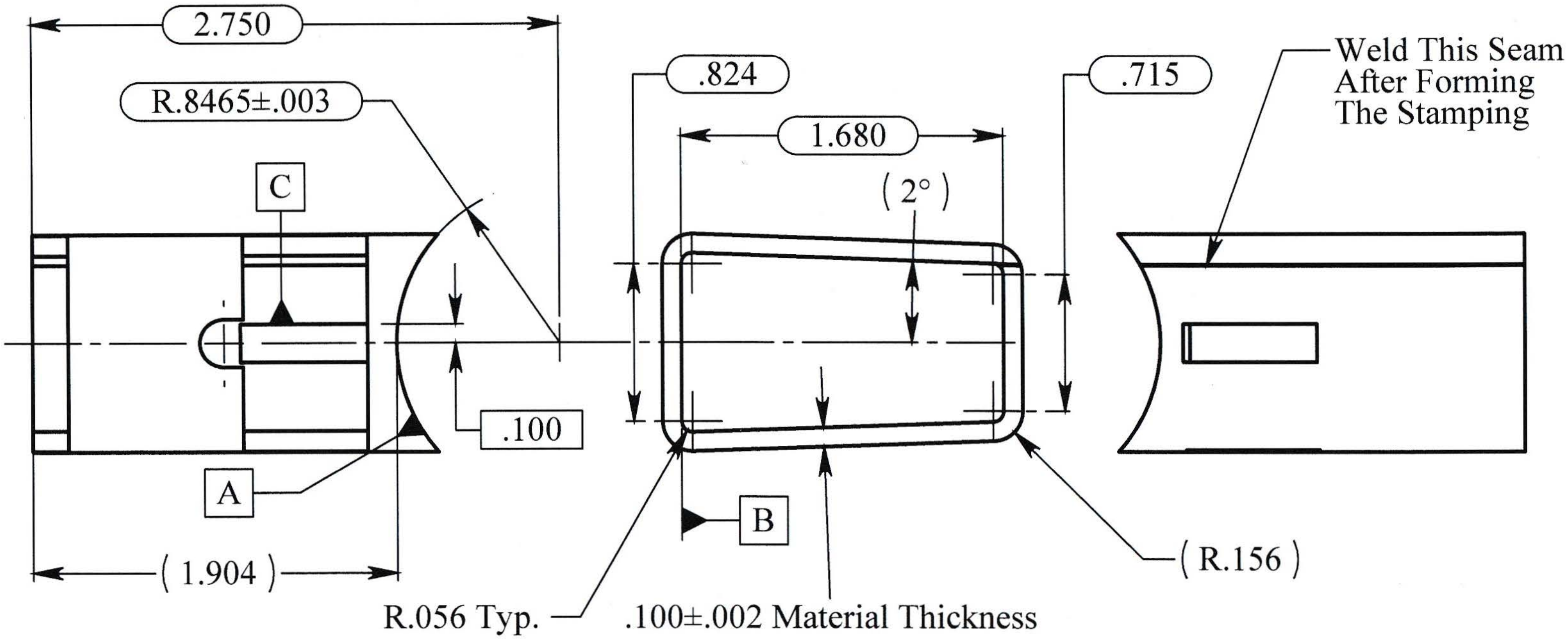
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance ⟶| |⟵ .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% ⟶| |⟵ C .XXX

Proprietary and Confidential

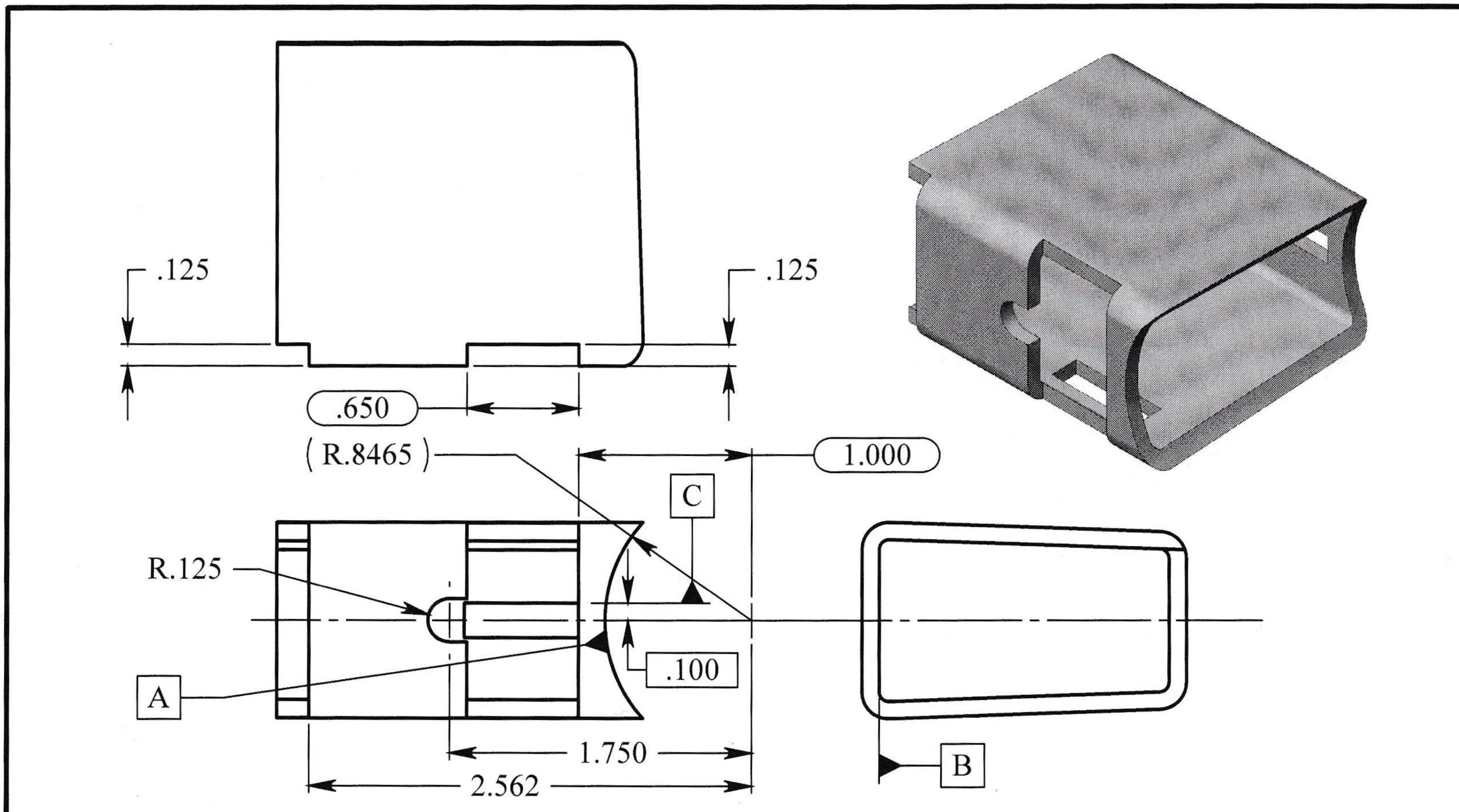
MATERIAL: AISI 1010	STEN MK II
HEAT TREAT: None	PART NAME: Mag. Housing Tube
HARDNESS: None	OPERATION NAME: Ejection Port
FINISH: None	OPERATION NO.: 20 — SCALE: 1:2



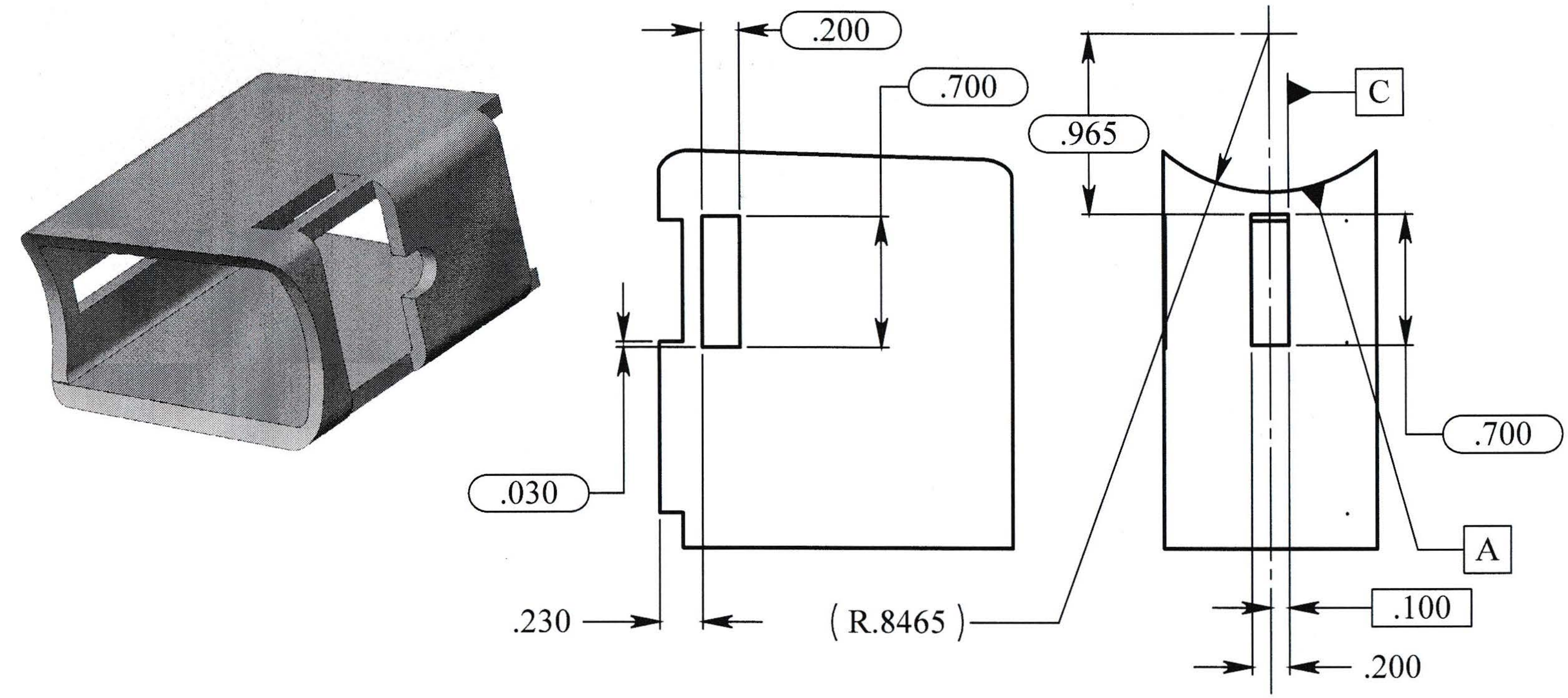
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010	STEN MK II	
		HEAT TREAT None	PART NAME Mag Housing Tube	
		HARDNESS None	OPERATION NAME Mag Opening	
	Proprietary and Confidential	FINISH None	OPERATION NO. 30	SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT	PART NAME Mag Latch Housing
		HARDNESS HRB 100 Min.	OPERATION NAME Outside Profile
	Proprietary and Confidential	FINISH None	OPERATION NO. 10 — SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT	PART NAME Mag Latch Housing
		HARDNESS HRB 100 Min.	OPERATION NAME Machining
	Proprietary and Confidential	FINISH None	OPERATION NO. 20 — SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010	STEN MK II	
		HEAT TREAT	PART NAME Mag Latch Housing	
		HARDNESS HRB 100 Min.	OPERATION NAME Punching	
	Proprietary and Confidential	FINISH None	OPERATION NO. 30	SCALE 1:1

Manufacturing Data:

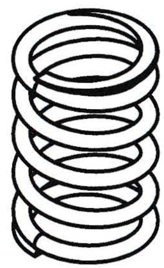
Spring Type:	Helical Compression
Outside Diameter:	.375 inches
Wire Diameter:	.044
Total Coils:	6.0
Active Coils:	4.0
Coil Type:	Closed and Ground
Free Length:	.625
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.564 inches
Load P1:	2.25 +/-.75 lbs.
Load Length L2:	.400 inches
Load P2:	8.4 lbs +/-.85 lbs.
Max. Solid Height:	.275 inches

Engineering Data:

Spring Rate:	37.1 lbs/in.
Spring Index:	7.5
Static Solid Stress:	158,800 psi
Stress Percentage: at Solid Height	51.0%



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL: Music Wire (ASTM A228)

HEAT TREAT: Stress Relieve

HARDNESS:

FINISH: Oiled

STEN MK II

PART NAME: Mag Latch Spring

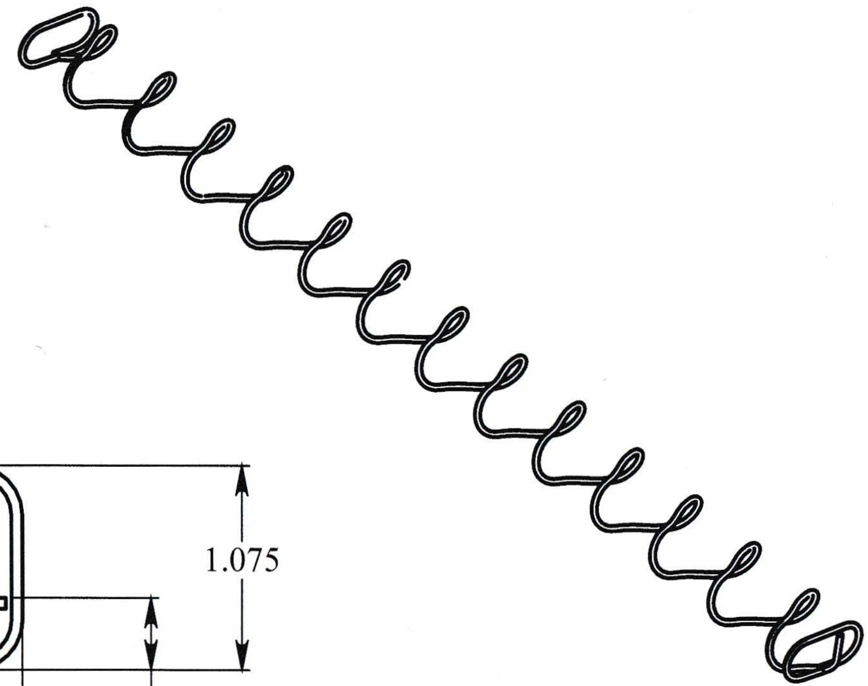
OPERATION NAME:

OPERATION NO.:

SCALE: 2:1

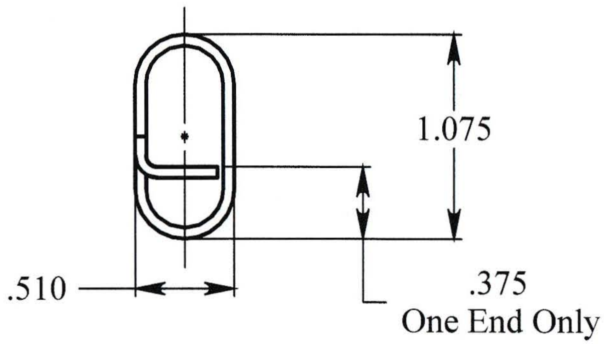
Inspection Data:

1. To work freely in a 1.100" x .535" rectangle
2. Load @ 8.50 = 5.8 Lbs +/- .6 lbs.
3. Solid Height Max.= 1.600"
4. Free Length Minimum = 12.375"

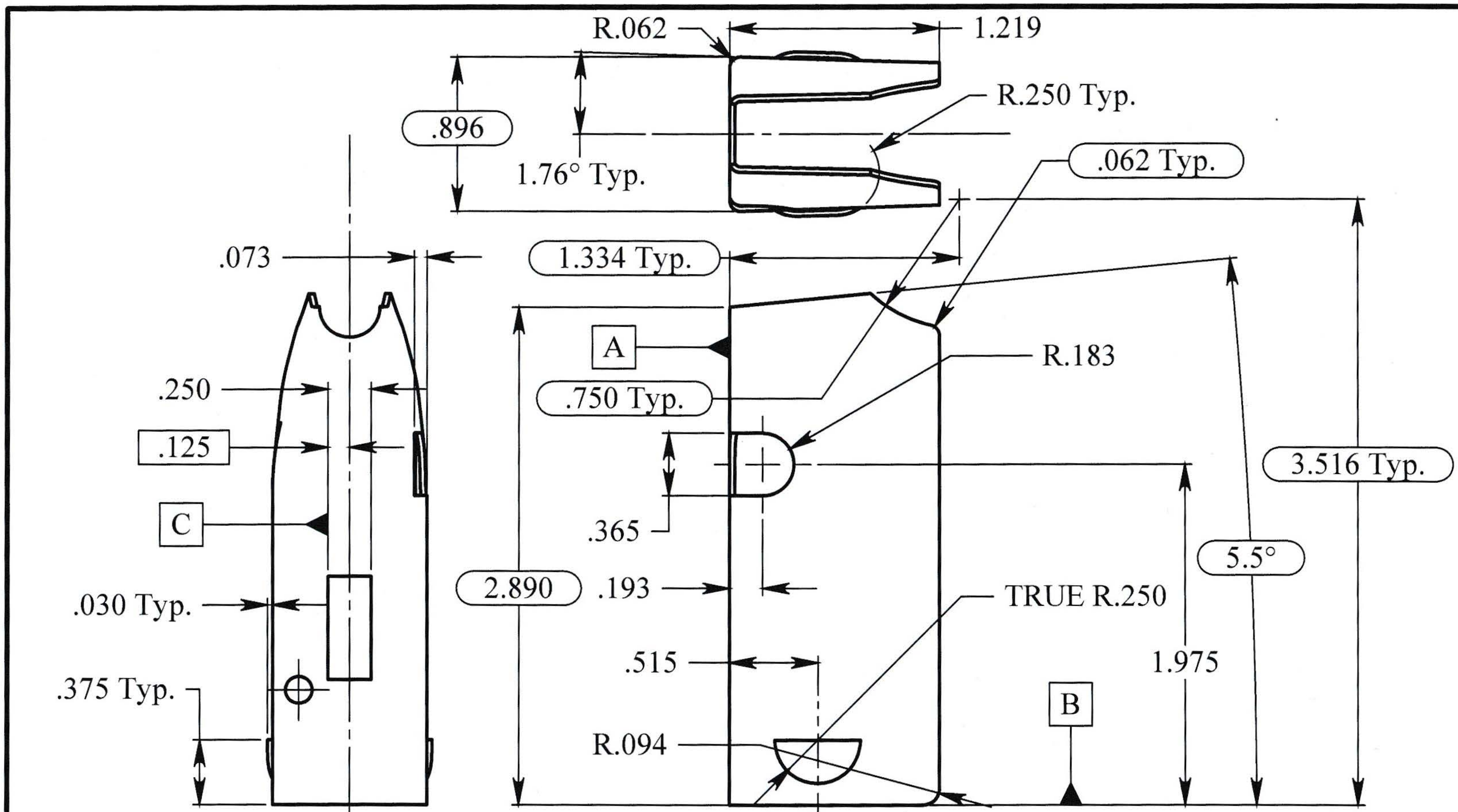


Manufacturing Data:

Free Length = 12.75" +/-.5
Coils Total = 27.5
Coils Active = 25.5
Ends = Squared, Not Ground
Wire Diameter = .056"
Wind = Right Hand



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL Music Wire (ASTM-A228)	STEN MK II
		HEAT TREAT Stress Relieve	PART NAME Magazine Spring
		HARDNESS	OPERATION NAME
	Proprietary and Confidential	FINISH Oiled	OPERATION NO. / SCALE 1:2



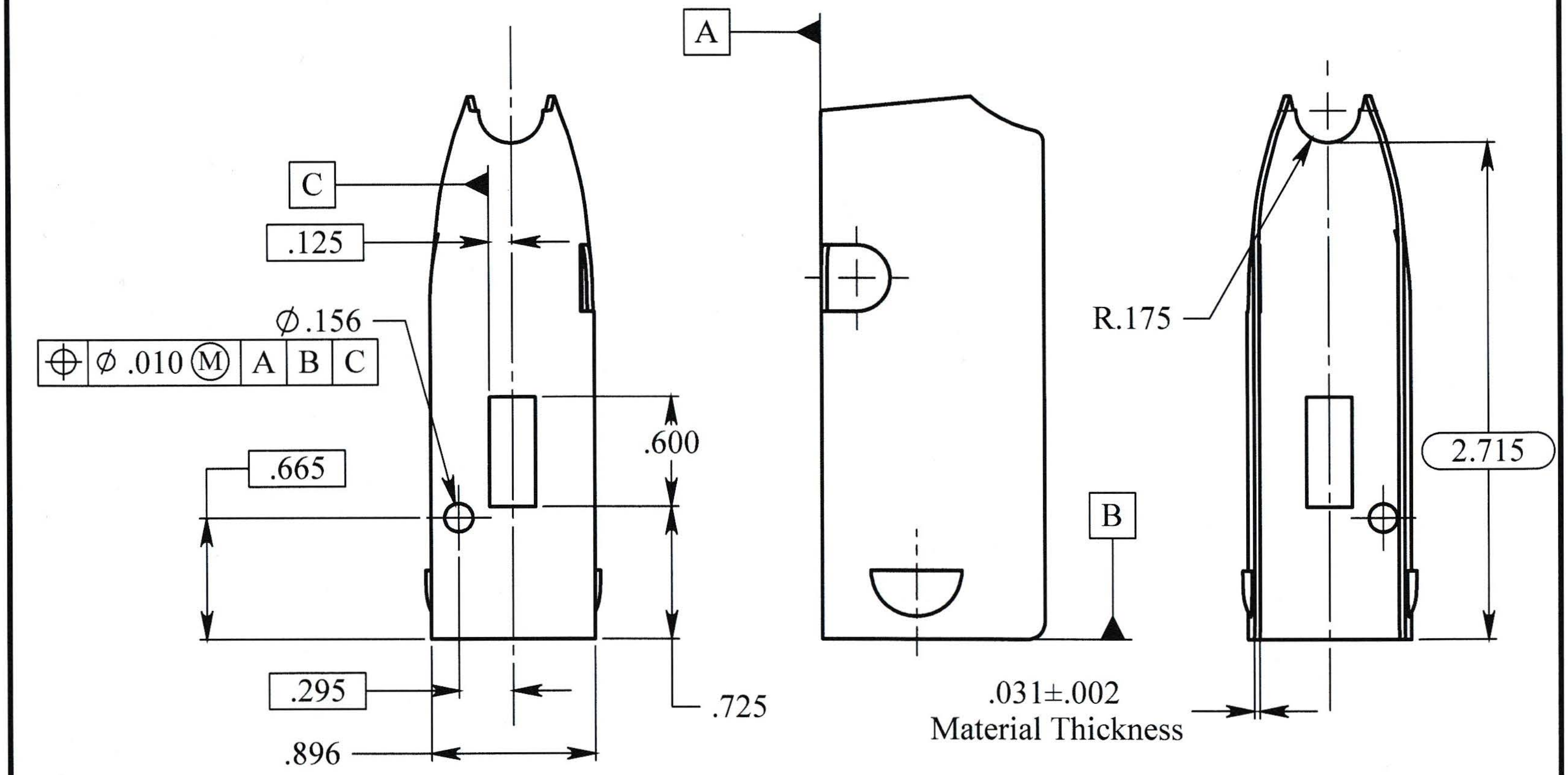
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

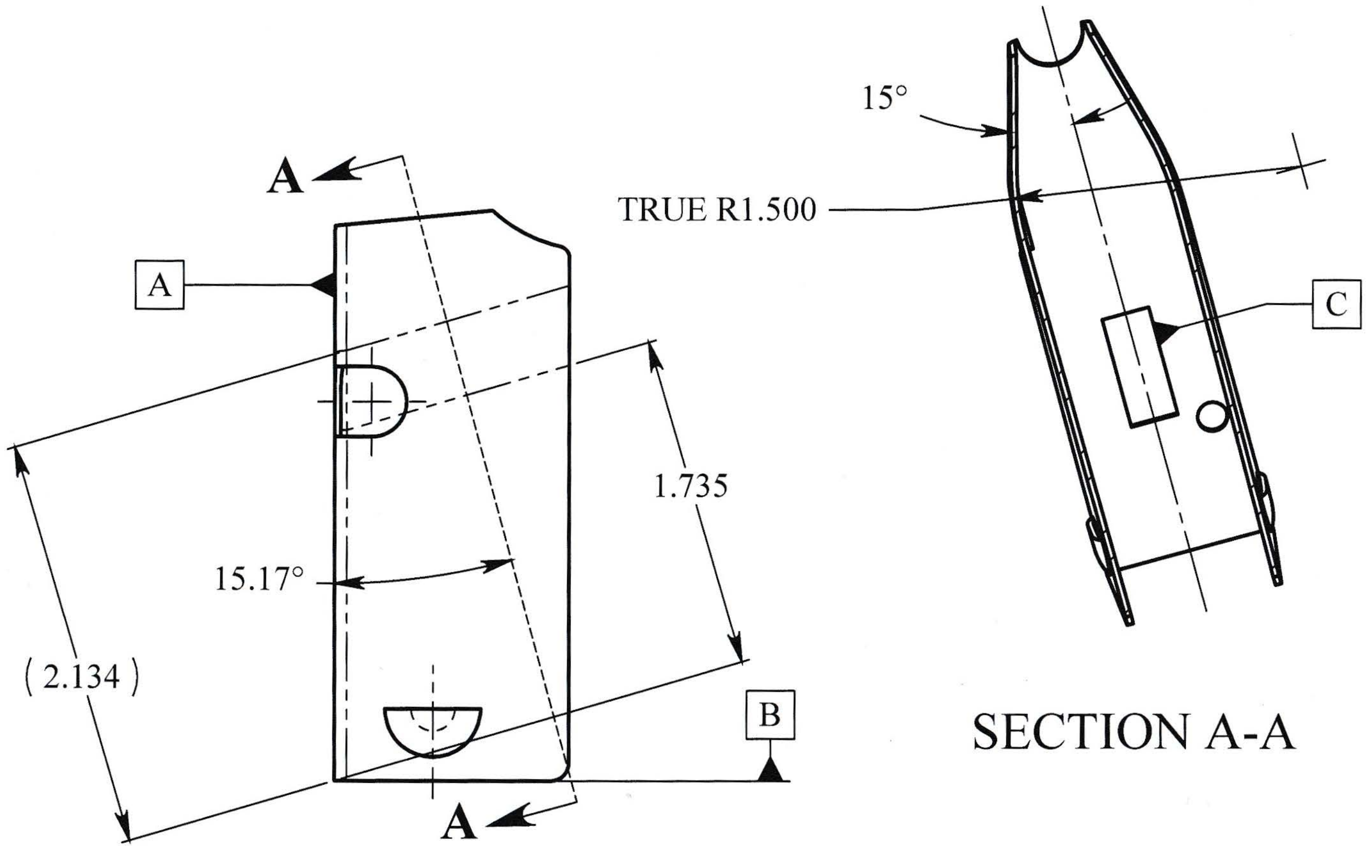
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II
HEAT TREAT	PART NAME Magazine Support
HARDNESS HRB 100 Min.	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 1:1

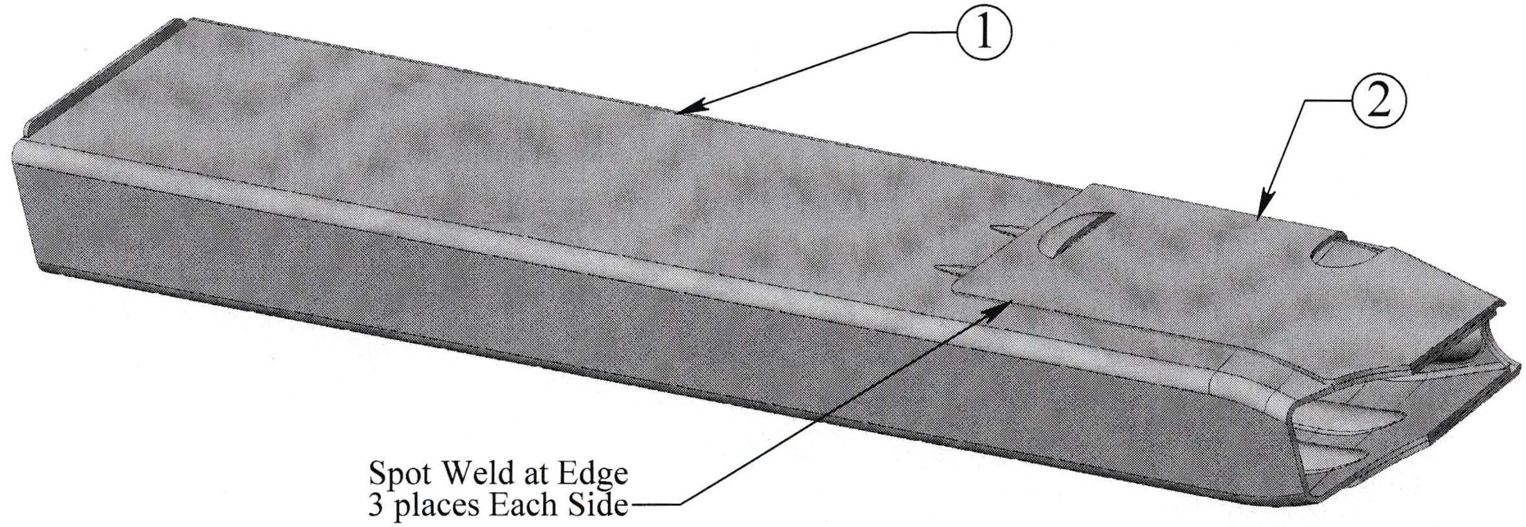


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 1010 HEAT TREAT HARDNESS HRB 100 Min. FINISH None	STEN MK II PART NAME Magazine Support OPERATION NAME End Cuts OPERATION NO. 20 SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT	PART NAME Magazine Support
		HARDNESS HRB 100 Min.	OPERATION NAME Lip Support
	Proprietary and Confidential	FINISH None	OPERATION NO. 30 / SCALE 1:1

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 1010	STEN MK II	
		HEAT TREAT	PART NAME Magazine Support	
		HARDNESS HRB 100 Min.	OPERATION NAME	
	Proprietary and Confidential	FINISH None	OPERATION NO. 40	SCALE 1:1



ITEM NO.	PART NUMBER	Quantity
1	Magazine Box	1
2	Mag Support	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

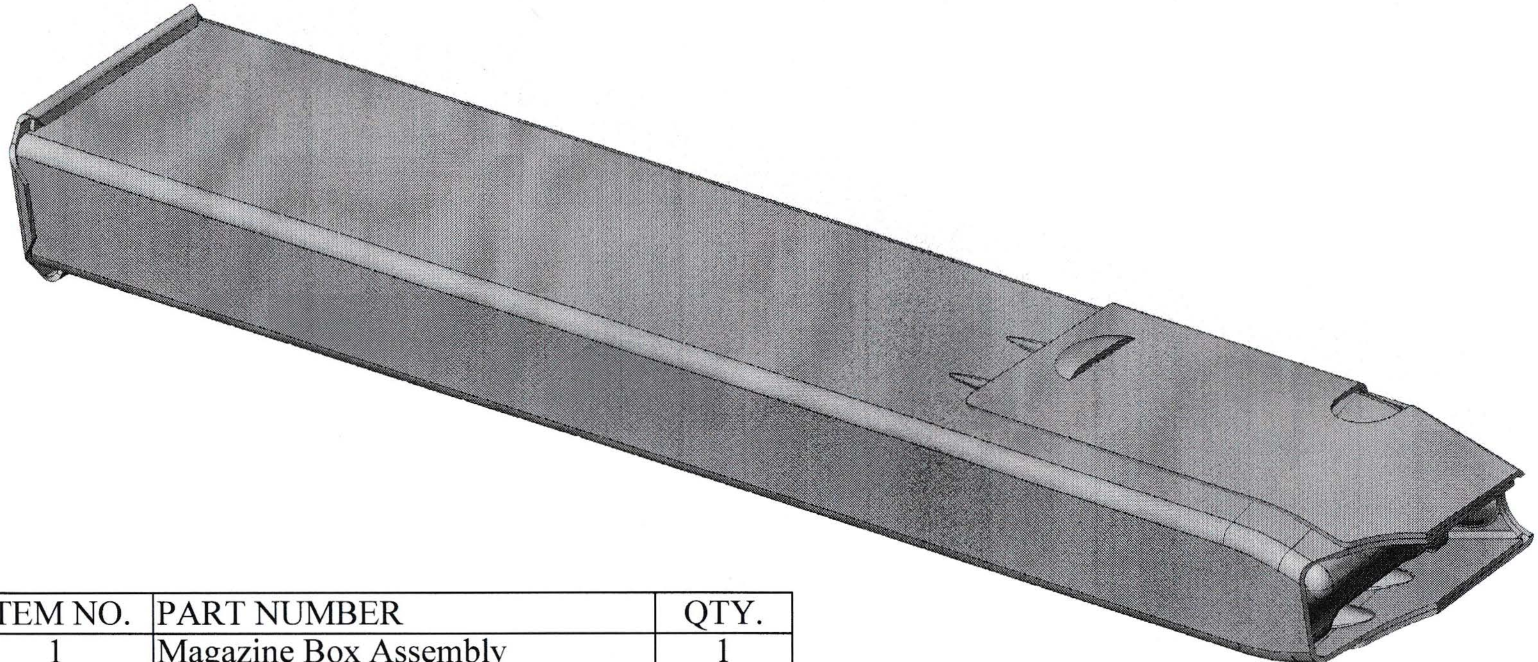
STEN MK II

PART NAME
Magazine Box Assembly

OPERATION NAME

OPERATION NO.

SCALE
1:1



ITEM NO.	PART NUMBER	QTY.
1	Magazine Box Assembly	1
2	Mag. Box Bottom	1
3	Mag Bottom Retainer	1
4	Magazine Follower Assembly	1
5	Magazine Spring	1

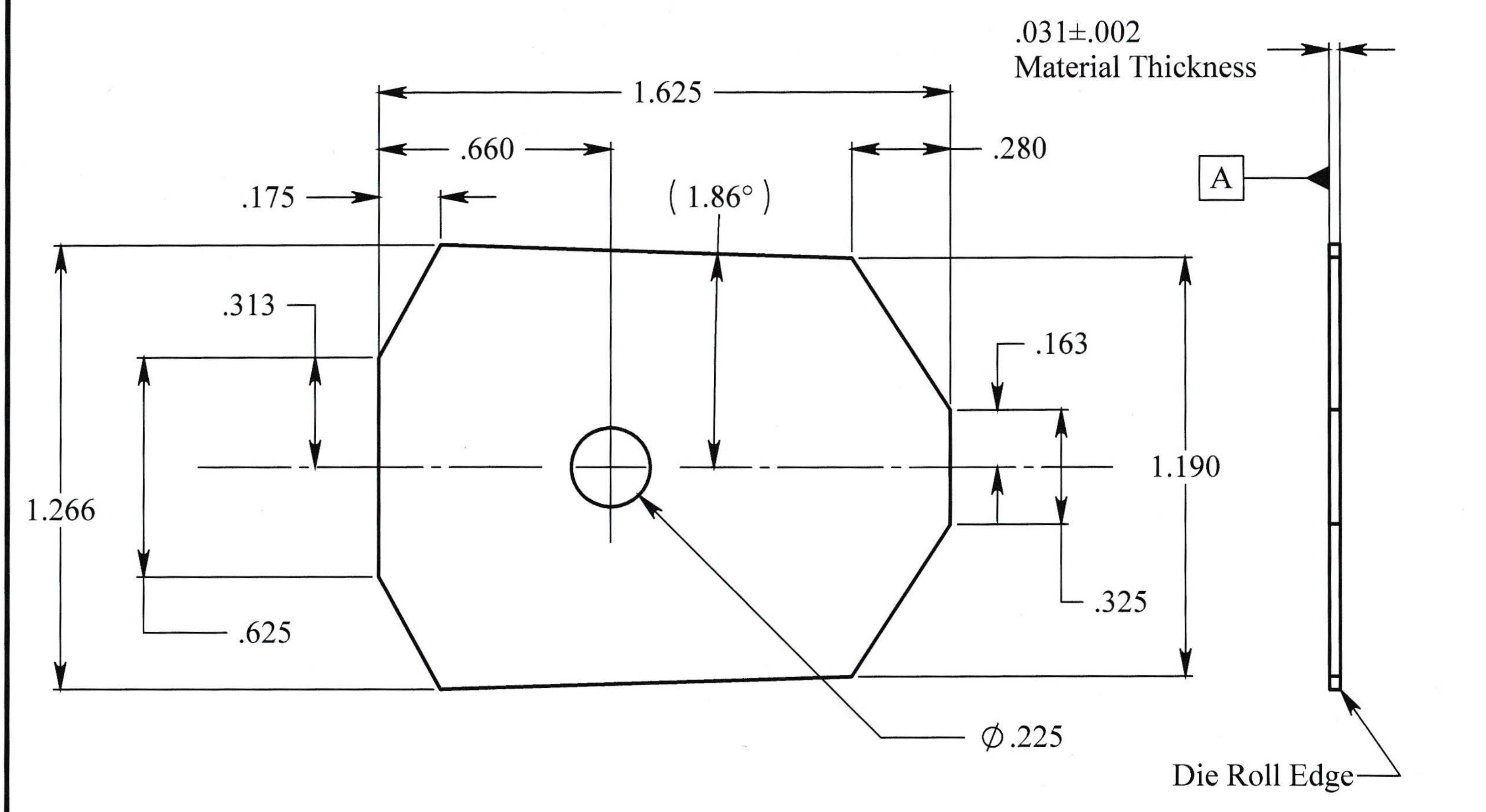
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

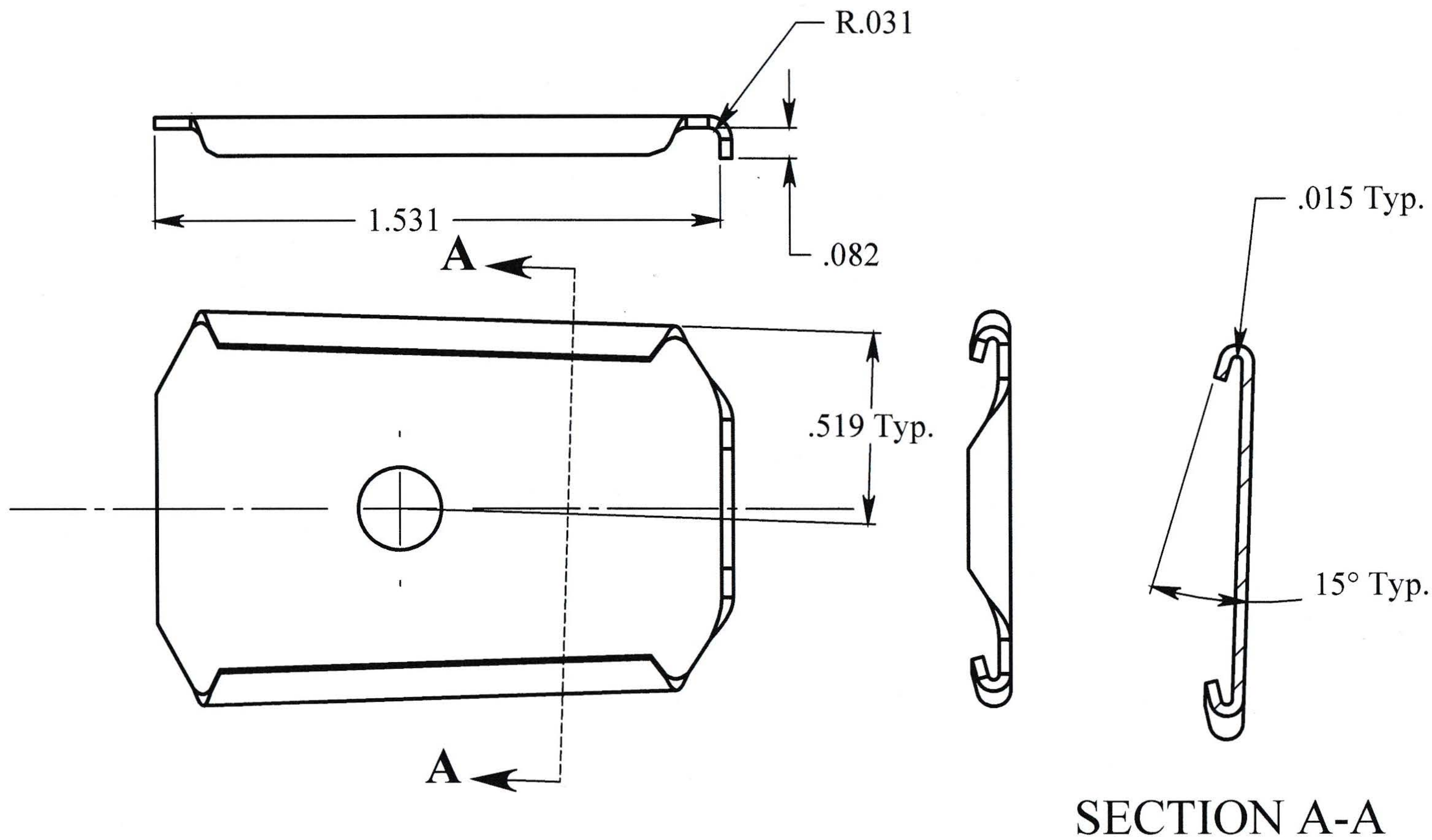
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

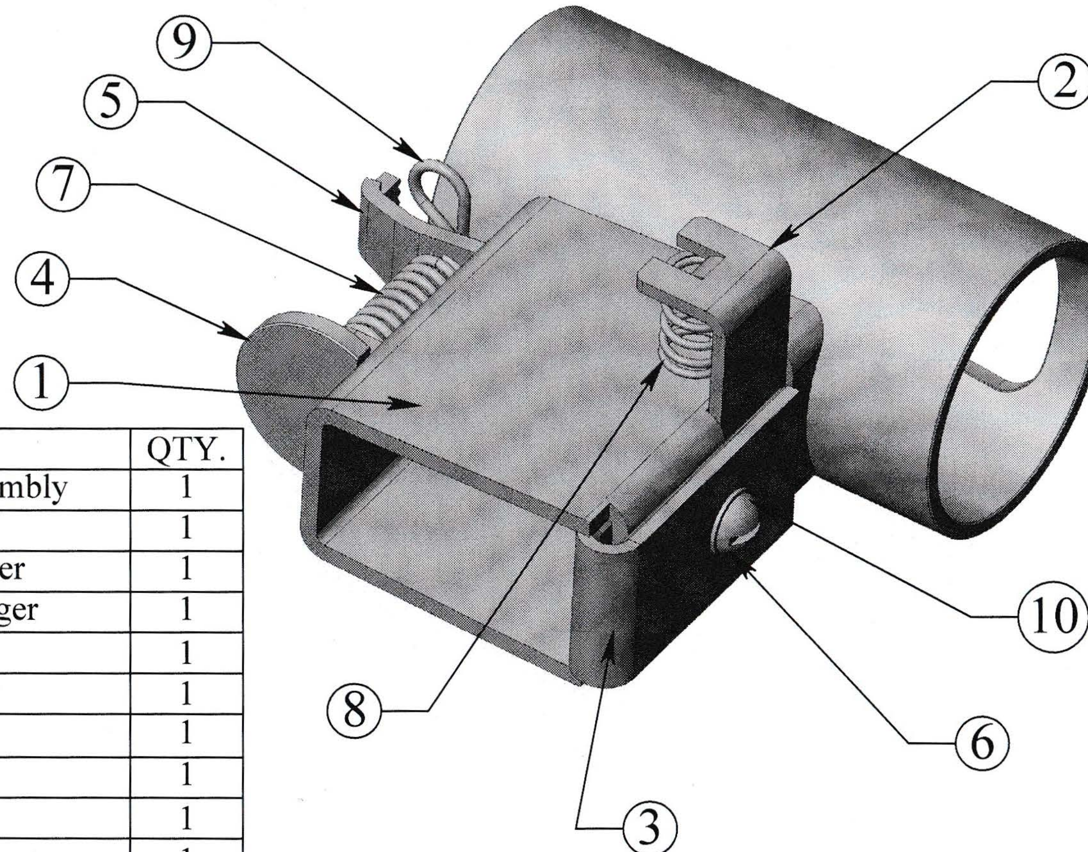
MATERIAL	STEN MK II
HEAT TREAT	PART NAME Mag Box Assy Complete
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT	PART NAME Mag Box Bottom
		HARDNESS HRB 100 Min.	OPERATION NAME Flat Pattern
	Proprietary and Confidential	FINISH None	OPERATION NO. 10 — SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX) Proprietary and Confidential	MATERIAL AISI 1010 HEAT TREAT HARDNESS HRB 100 Min. FINISH Black Oxide	STEN MK II PART NAME Mag Box Bottom OPERATION NAME Forming OPERATION NO. 20 SCALE 2:1



ITEM NO.	PART NUMBER	QTY.
1	Magazine Housing Assembly	1
2	Magazine Latch	1
3	Magazine Housing Spacer	1
4	Magazine Housing Plunger	1
5	Barrel Nut Catch	1
6	Lock Washer	1
7	Plunger Spring	1
8	Mag Latch Spring	1
9	Hitch_Pin	1
10	Screw	1

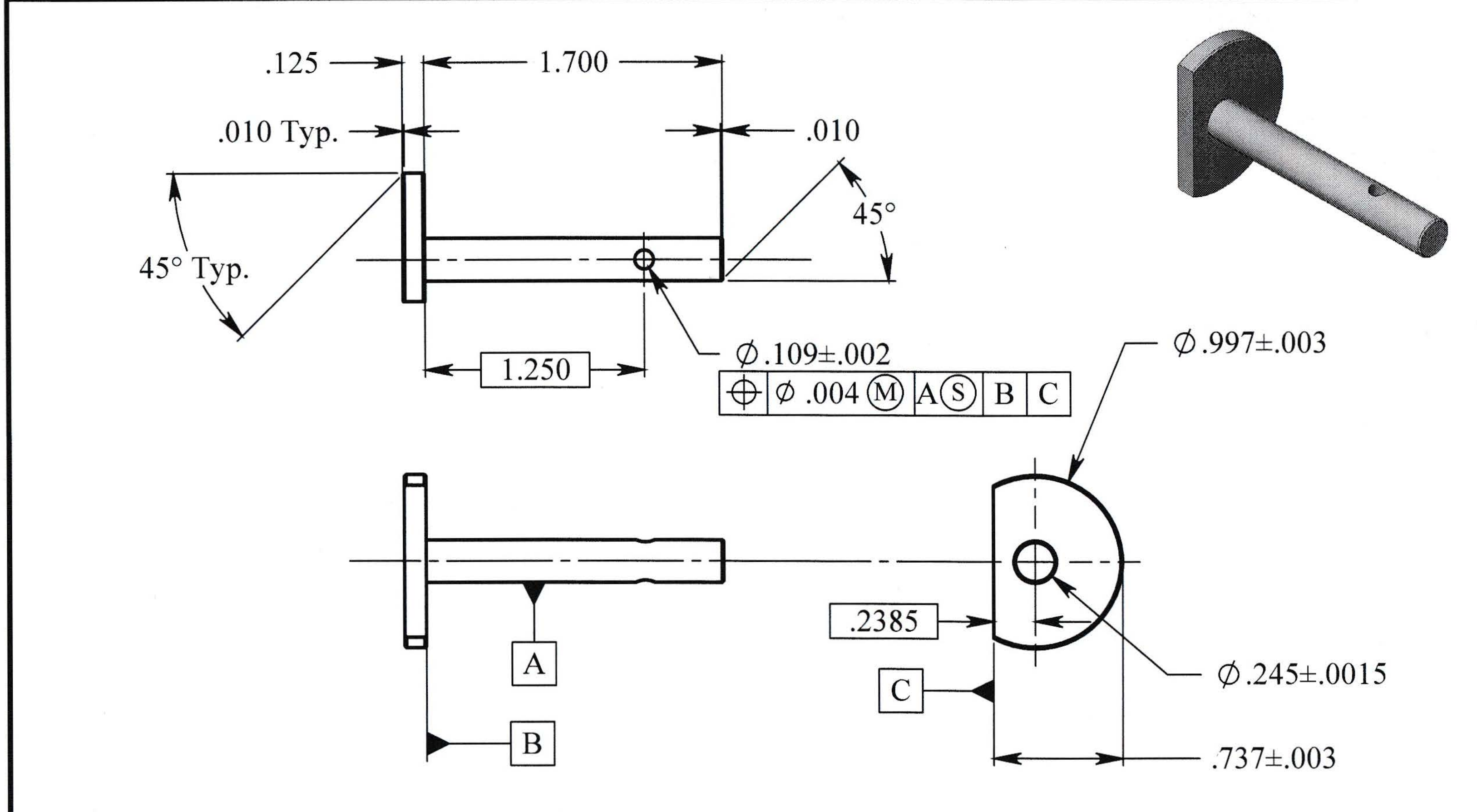
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

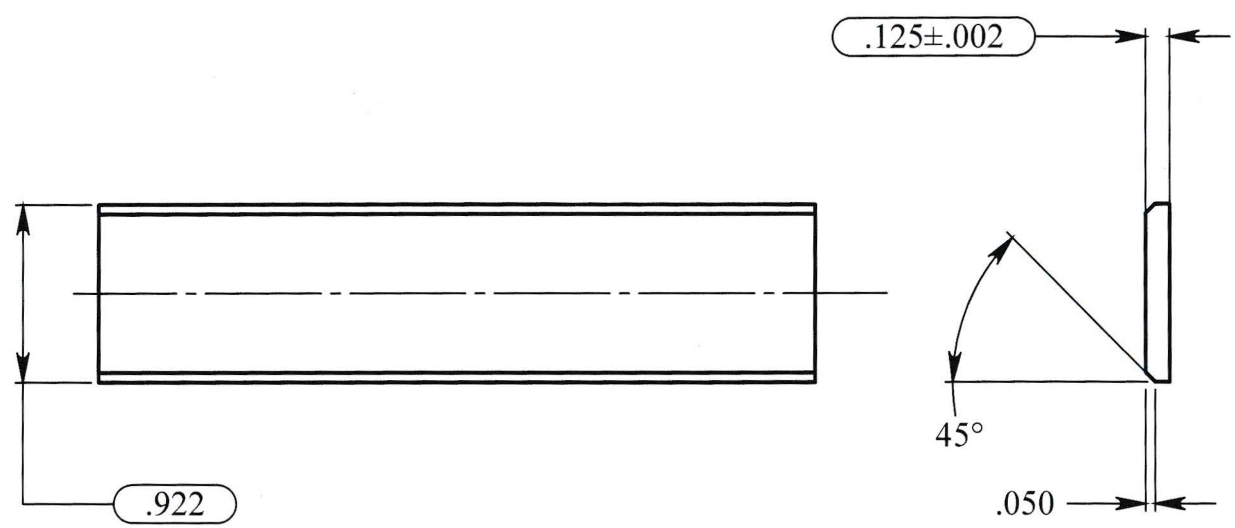
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance →| |← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |← C .XXX

Proprietary and Confidential

MATERIAL	STEN MK II
HEAT TREAT	PART NAME Mag. Housing Assembly Complete
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT	PART NAME Mag. Housing Plunger
		HARDNESS	OPERATION NAME
	Proprietary and Confidential	FINISH	OPERATION NO. / SCALE 1:1



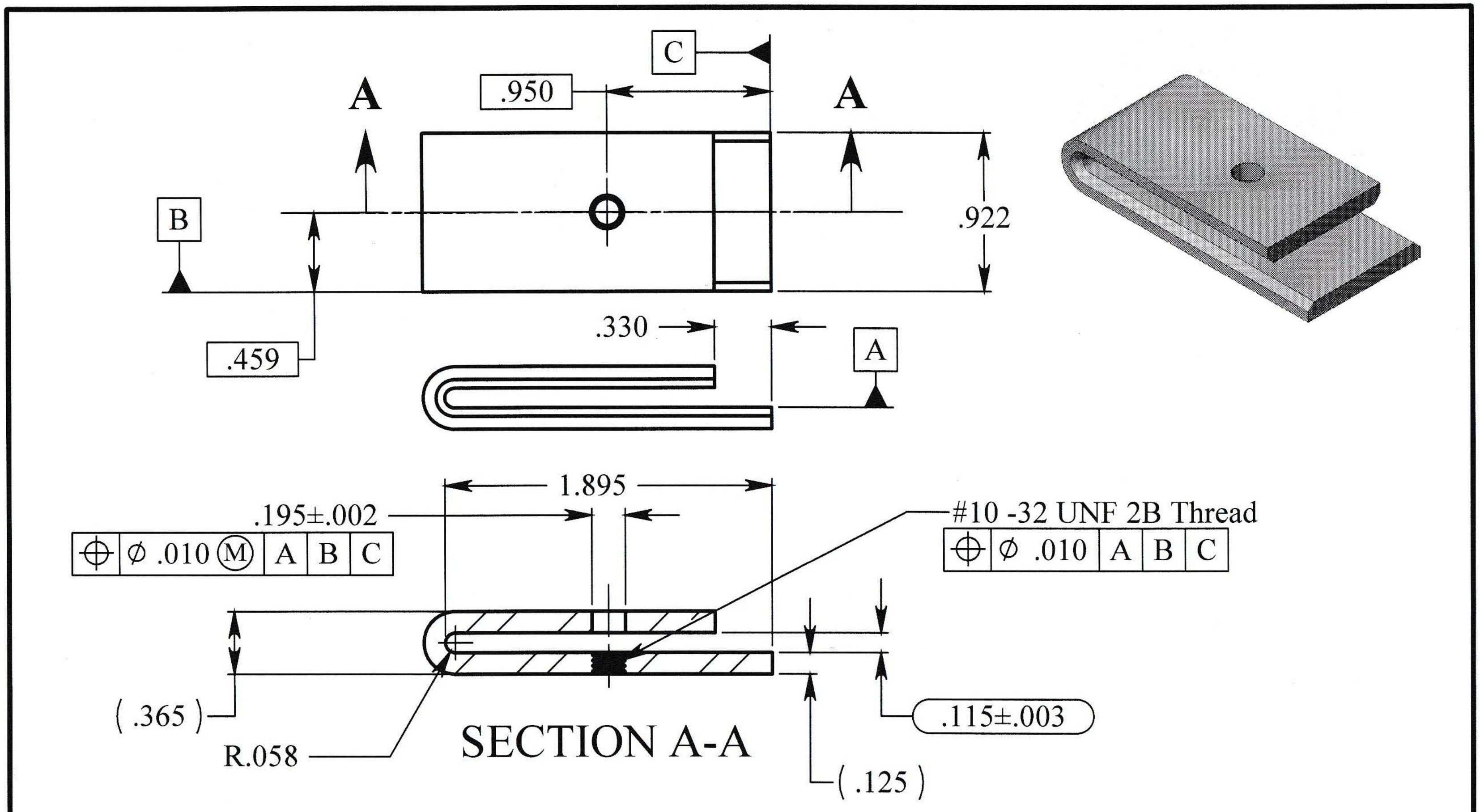
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II
HEAT TREAT	PART NAME Mag. Housing Spacer
HARDNESS	OPERATION NAME Flat Pattern
FINISH	OPERATION NO. 10 / SCALE 1:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL
AISI 1010

HEAT TREAT
Carburize .7C

HARDNESS
HR15N 88 - 92

FINISH
Black Oxide

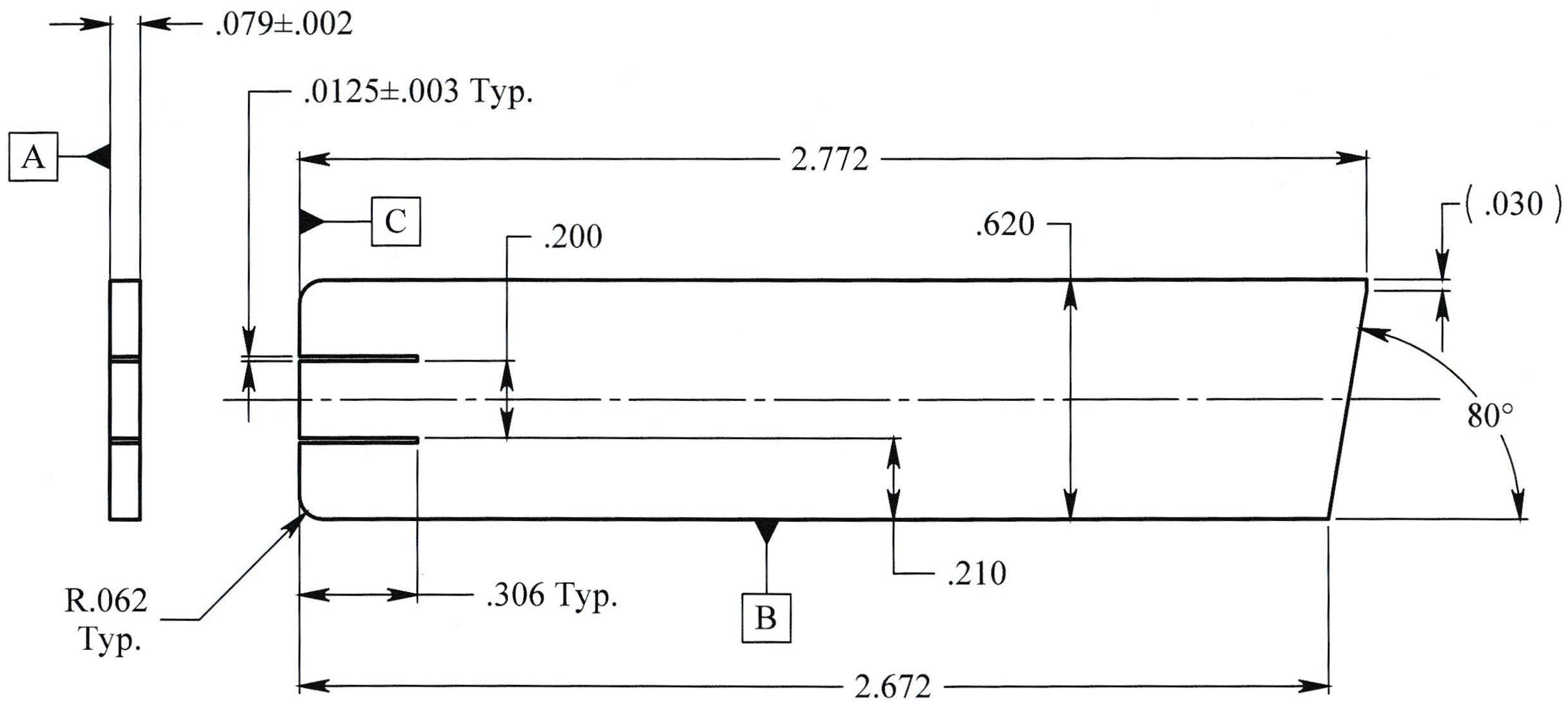
STEN MK II

PART NAME
Mag. Housing Spacer

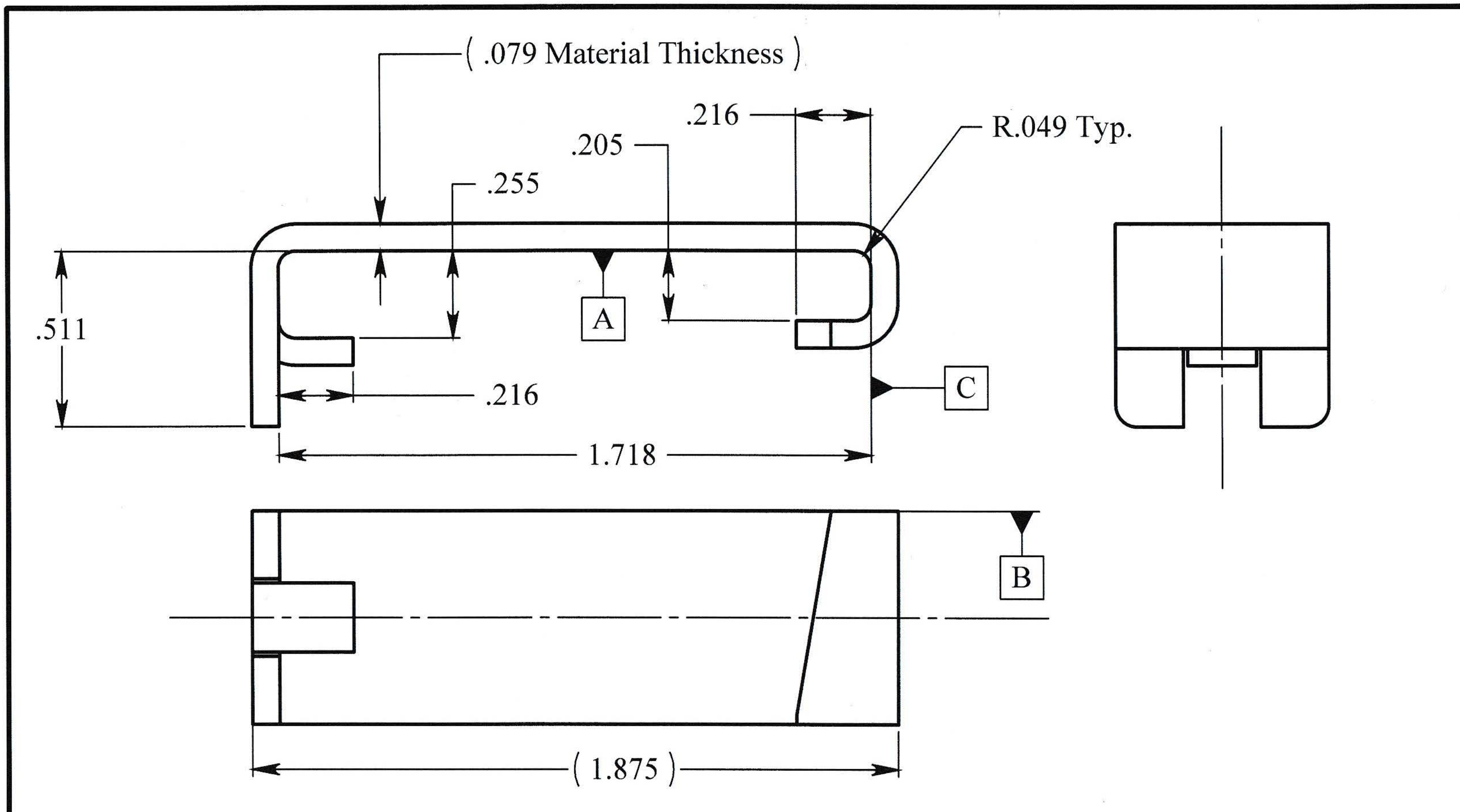
OPERATION NAME
Form and Threading

OPERATION NO.
20

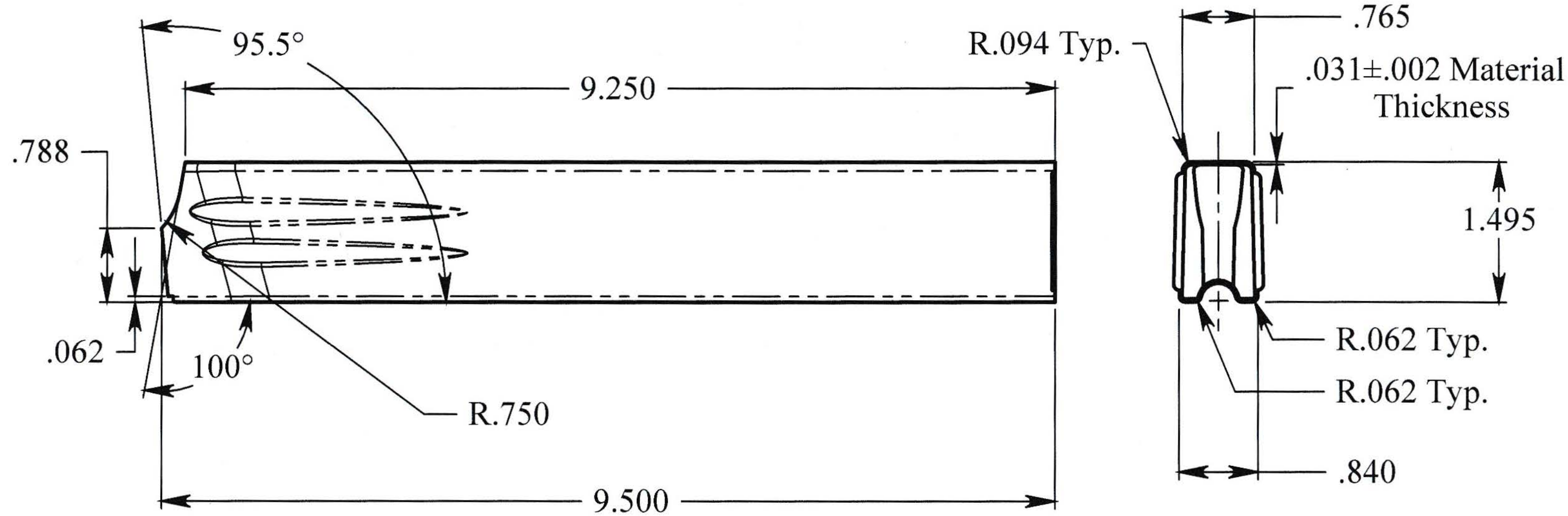
SCALE
1:1

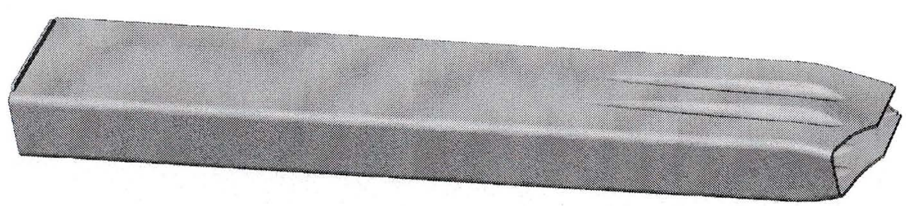


Dimensions are in Inches	Notes:	MATERIAL AISI 1118	STEN MK II	
Tolerances: Fractional = ± .015; Angular = ± .5°; Two place decimal = ± .010; Three place dec. = ± .005	1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX	HEAT TREAT None	PART NAME Mag Latch	
	2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	HARDNESS None	OPERATION NAME Flat Pattern	
	Proprietary and Confidential	FINISH None	OPERATION NO. 10	SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT Carburize .7C	PART NAME Mag Latch
		HARDNESS HR15N 88 - 92	OPERATION NAME Forming
		FINISH Black Oxide	OPERATION NO. 20 SCALE 2:1





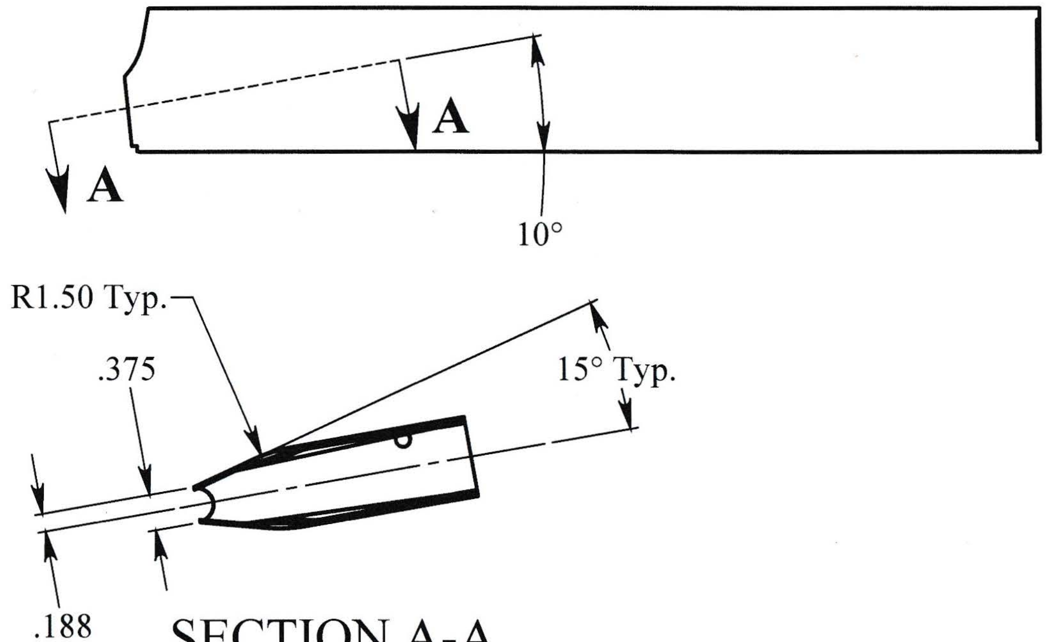
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT	PART NAME Magazine Box
HARDNESS HRB 100 Min.	OPERATION NAME Profile
FINISH Black Oxide	OPERATION NO. 10 — SCALE 1:2



SECTION A-A
SCALE 1 : 2

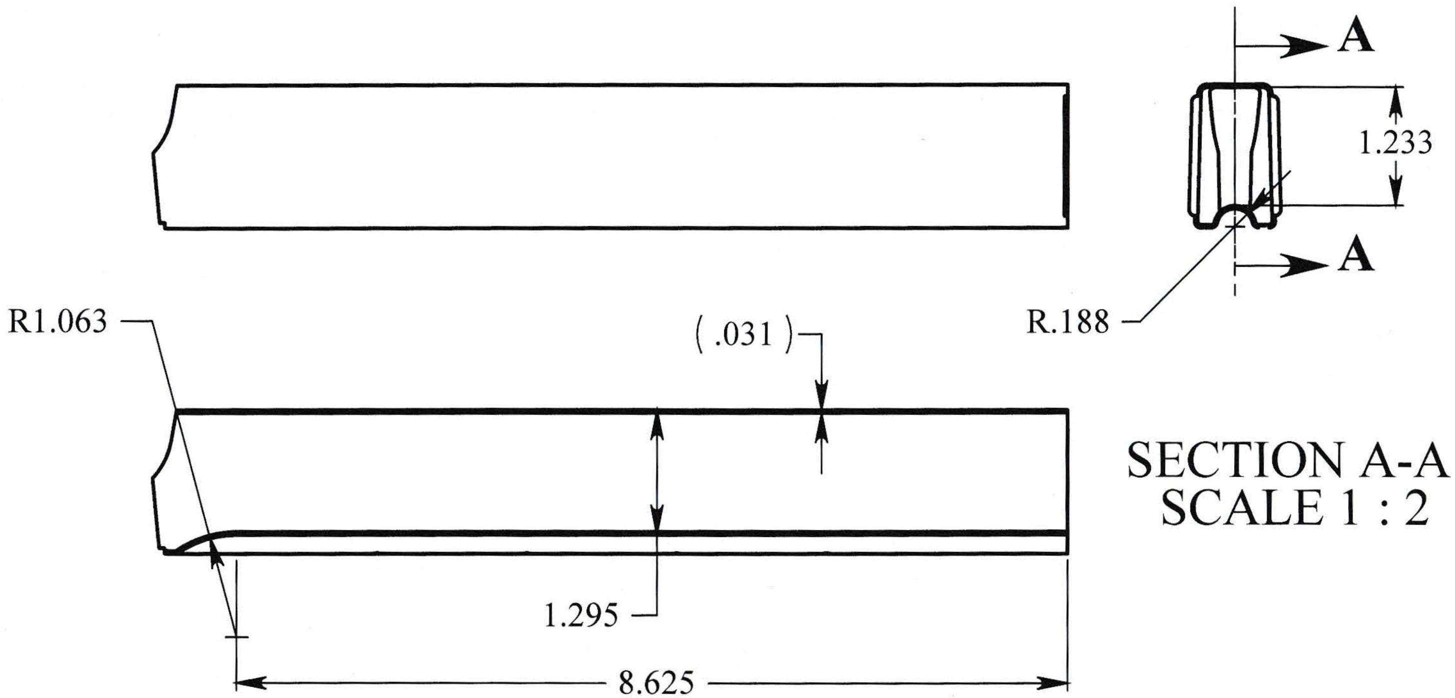
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

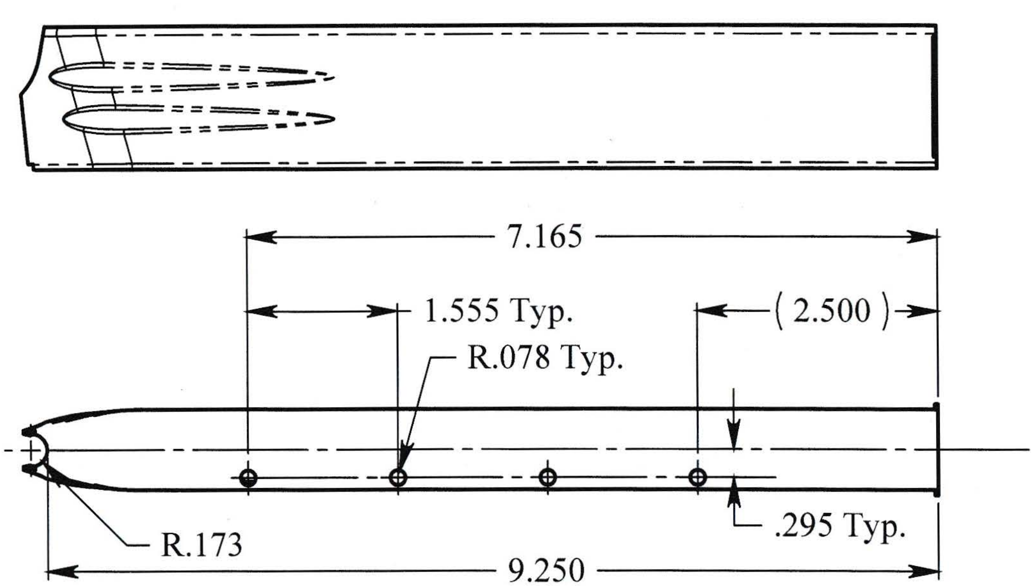
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT	PART NAME Magazine Box
HARDNESS HRB 100 Min.	OPERATION NAME Lip Profile
FINISH Black Oxide	OPERATION NO. 20 — SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 1118 HEAT TREAT HARDNESS HRB 100 Min. FINISH Black Oxide	STEN MK II PART NAME Magazine Box OPERATION NAME Rear Groove OPERATION NO. 30 SCALE 1:2



Dimensions are in Inches

Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

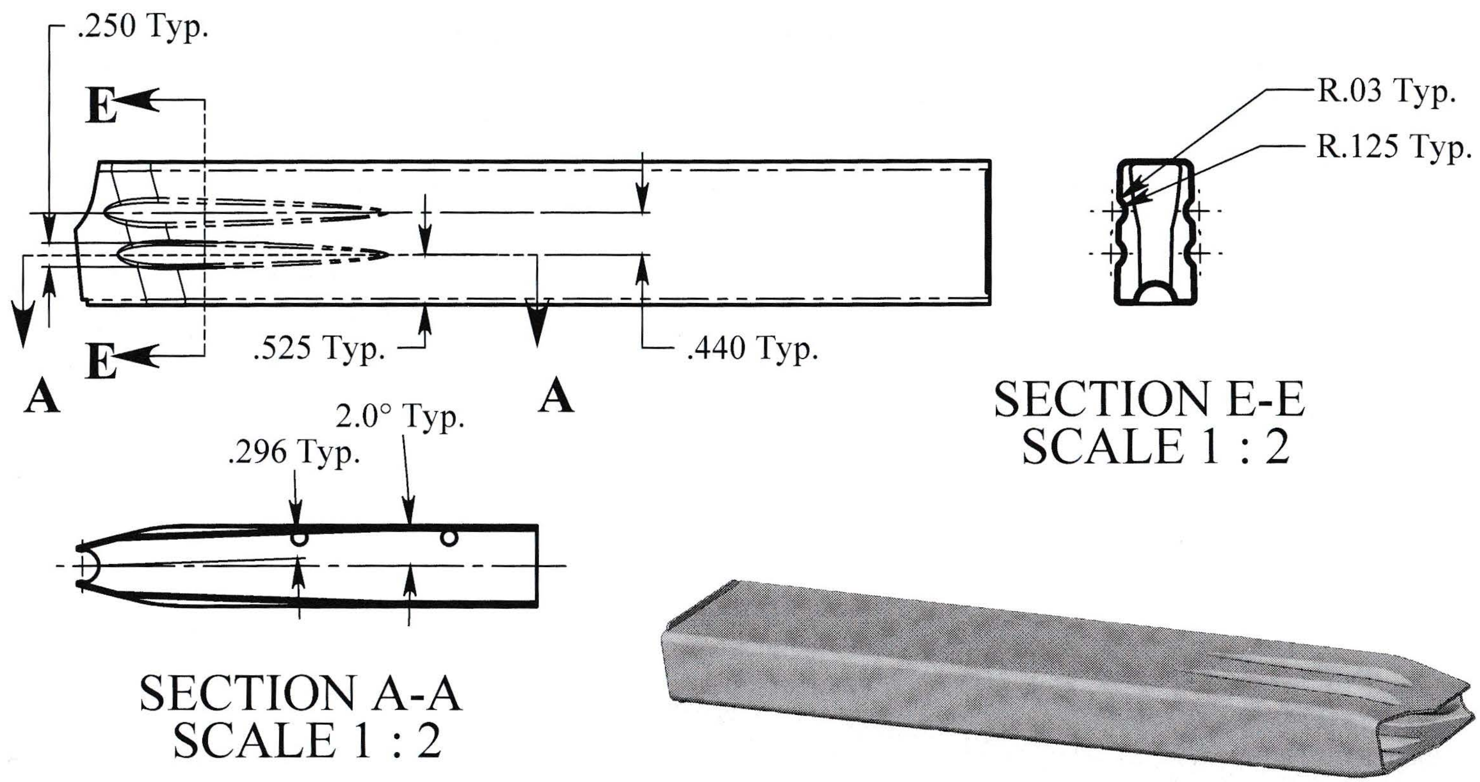
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

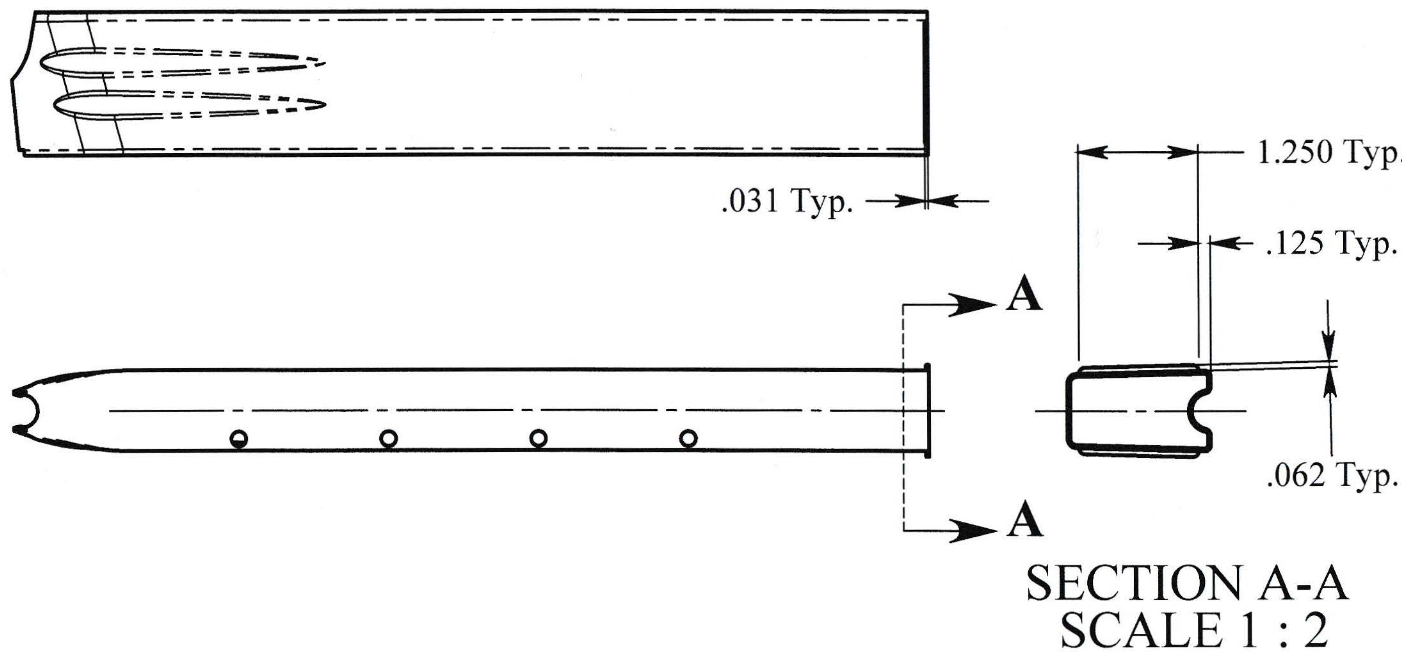
MATERIAL	AISI 1118
HEAT TREAT	
HARDNESS	HRB 100 Min.
FINISH	Black Oxide

STEN MK II

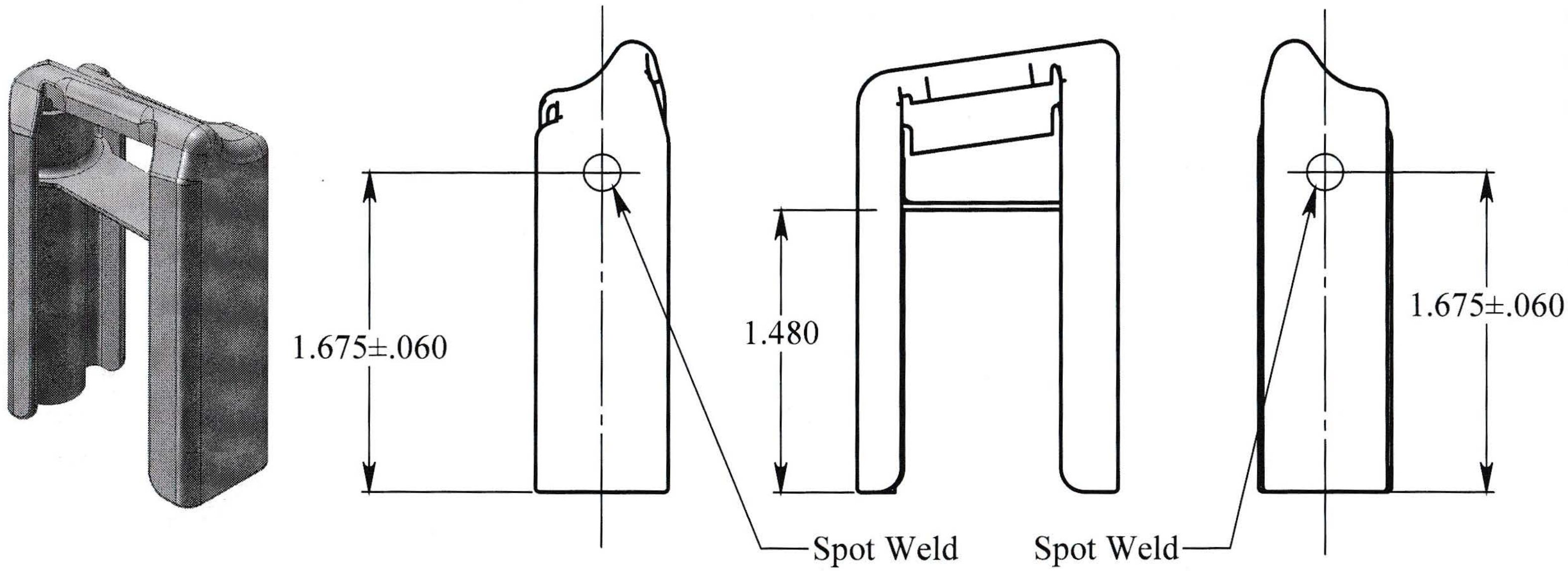
PART NAME	Magazine Box
OPERATION NAME	Rear View
OPERATION NO.	40
SCALE	1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT	PART NAME Magazine Box
		HARDNESS HRB 100 Min.	OPERATION NAME Ribs
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 50 — SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX) Proprietary and Confidential	MATERIAL AISI 1118 HEAT TREAT HARDNESS HRB 100 Min. FINISH Black Oxide	STEN MK II PART NAME Magazine Box OPERATION NAME Bottom Flange OPERATION NO. 60 — SCALE 1:2



ITEM NO.	PART NUMBER	QTY.
1	Mag Follower	1
2	Mag Follower Support	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH
Black Oxide

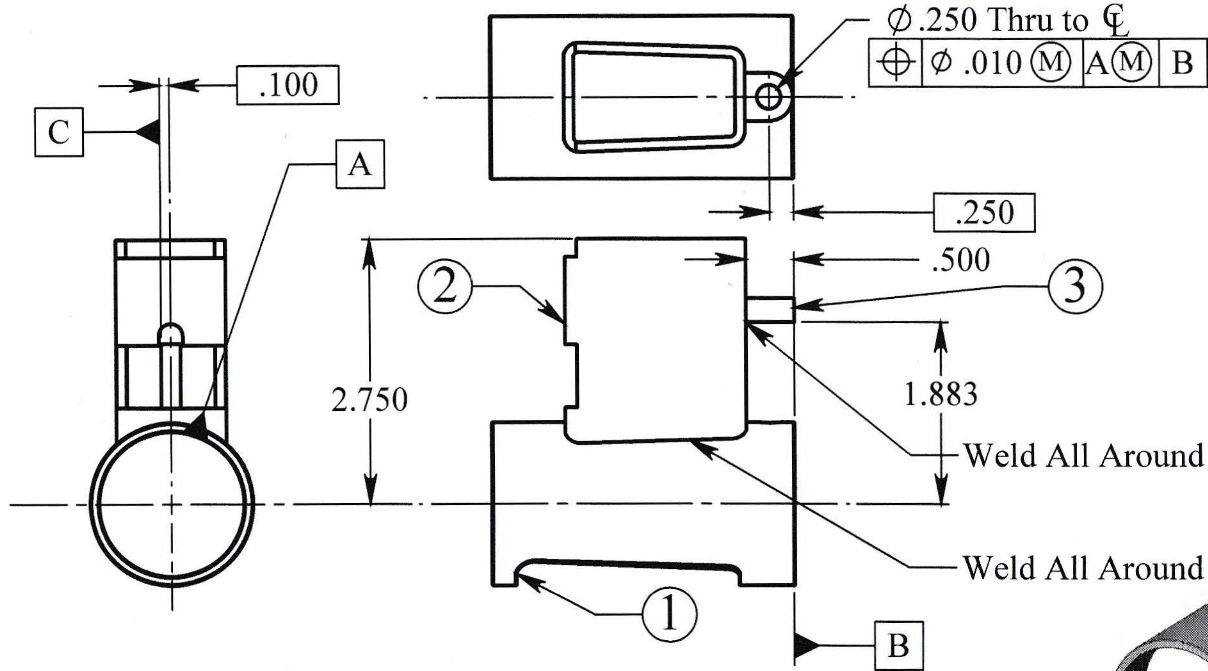
STEN MK II

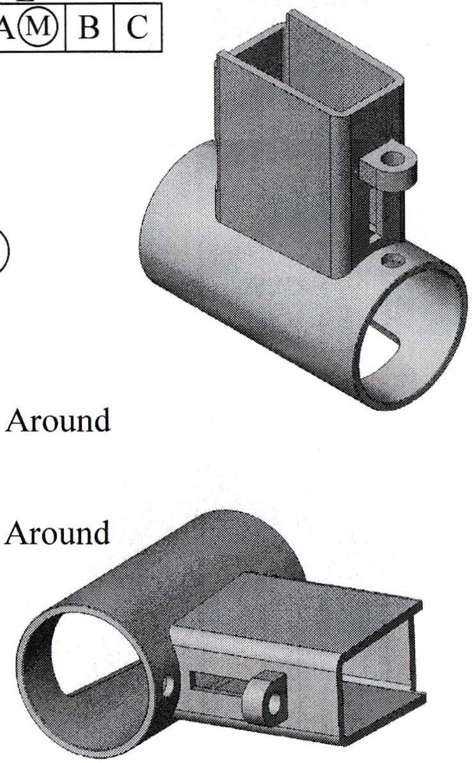
PART NAME
Mag Follower Assembly

OPERATION NAME

OPERATION NO.

SCALE
1:1





ITEM NO.	PART NUMBER	QTY.
1	Mag Housing Tube	1
2	Mag Latch Housing	1
3	Mag Housing Stud	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Mag Housing Assembly
HARDNESS None	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 1:2

Manufacturing Data:

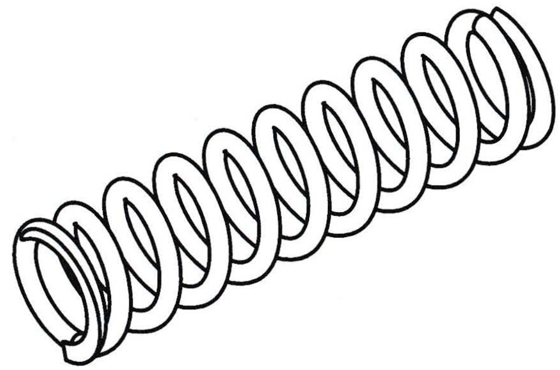
Spring Type:	Helical Compression
Outside Diameter:	.394 inches
Wire Diameter:	.056
Total Coils:	10.5
Active Coils:	8.5
Coil Type:	Closed and Ground
Free Length:	1.062
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.824 inches
Load P1:	10.25 +/-1.5 lbs.
Load Length L2:	.750 inches
Load P2:	13.4 lbs +/-1.6 lbs.
Max. Solid Height:	.625 inches
Spring works over:	.25 diameter rod

Engineering Data:

Spring Rate:	43.1 lbs/in.
Spring Index:	6.0
Static Solid Stress:	125,200 psi
Stress Percentage: at Solid Height	41.8%



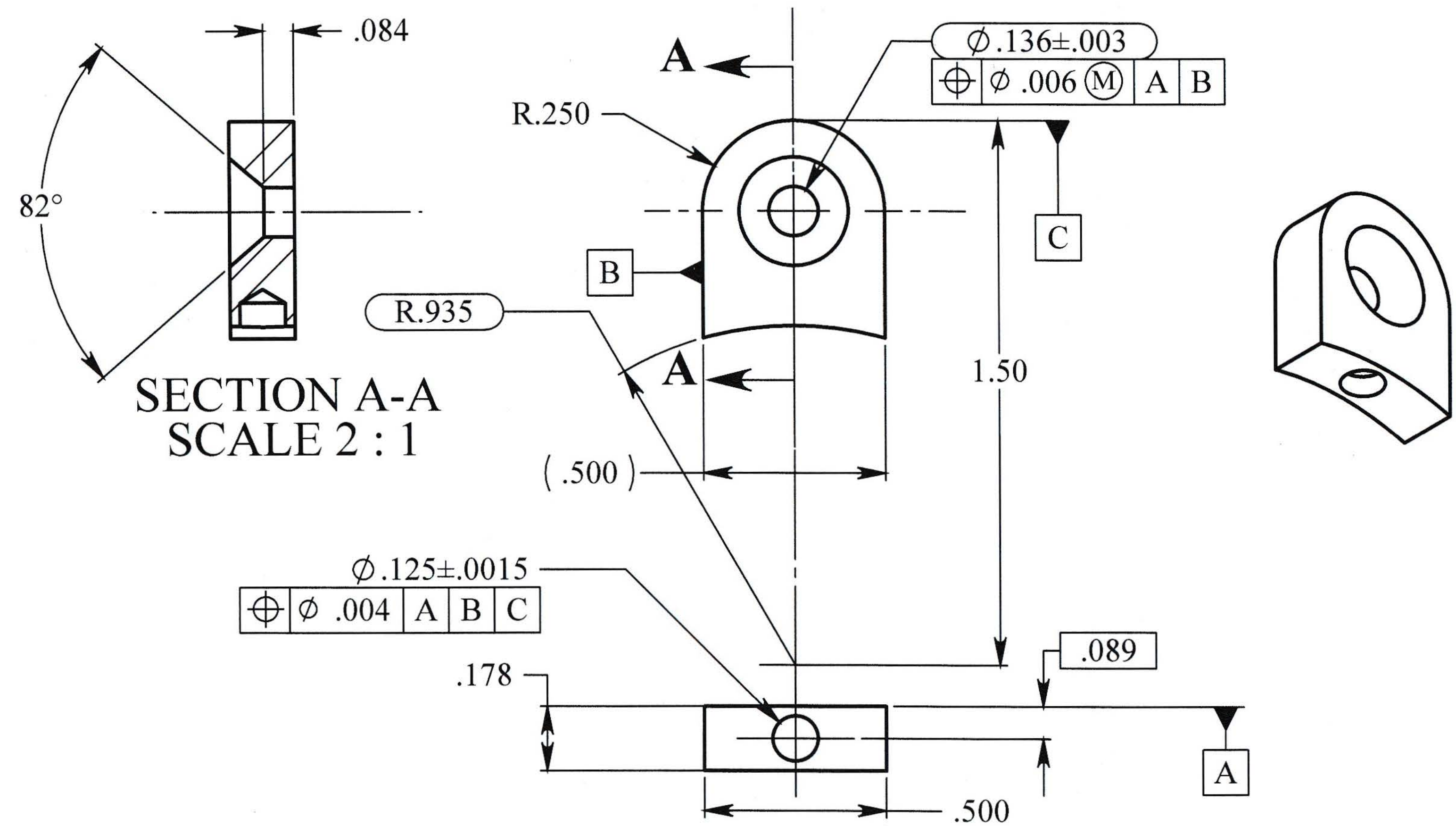
Dimensions are in Inches

Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

MATERIAL: Music Wire (ASTM A228)	STEN MK II
HEAT TREAT: Stress Relieve	PART NAME: Plunger Spring
HARDNESS:	OPERATION NAME:
FINISH: Oiled	OPERATION NO.: — SCALE: 4:1



Dimensions are in Inches

Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

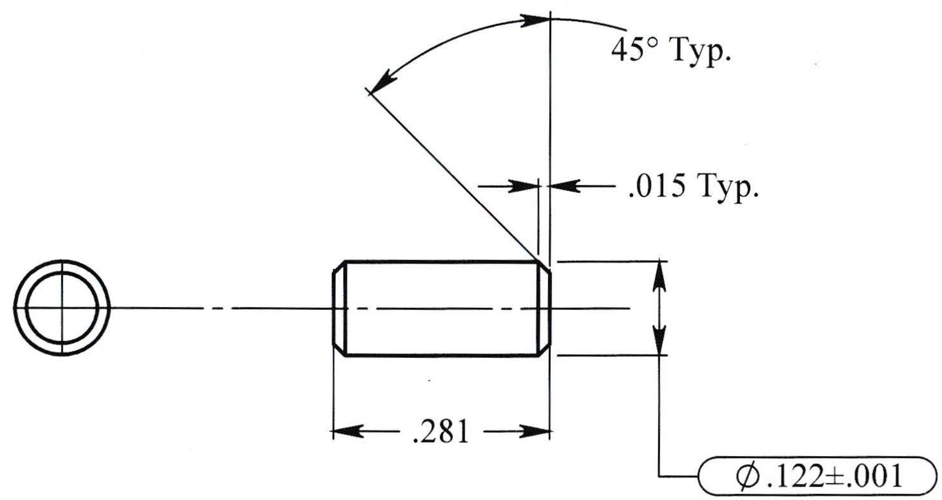
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL	AISI 1118
HEAT TREAT	None
HARDNESS	HRB 100 Min.
FINISH	None

STEN MK II

PART NAME	Rear Sight
OPERATION NAME	
OPERATION NO.	
SCALE	2:1



Dimensions are in Inches

Tolerances:

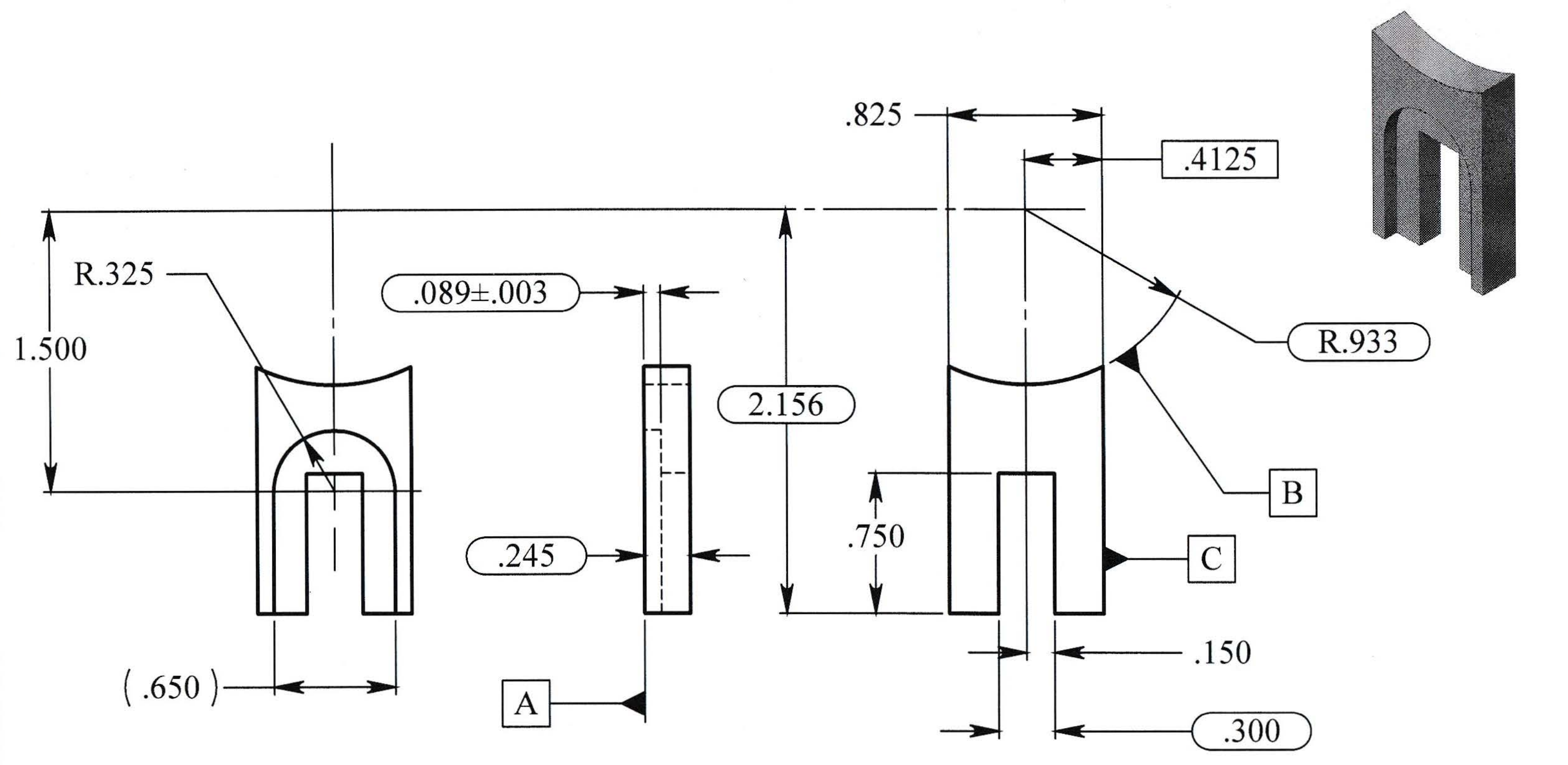
Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:

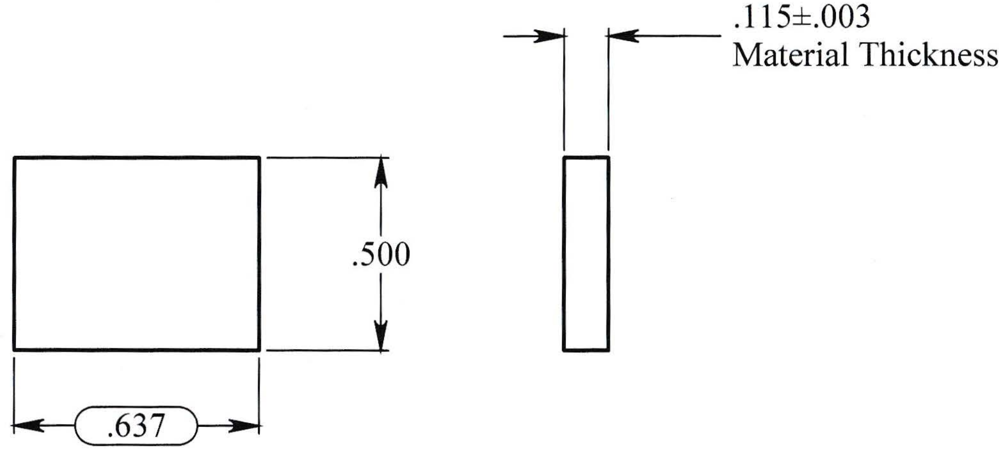
1. Dimension shown with this symbol are important and must be inspected for part conformance → ⟵ .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ⟵ C .XXX

Proprietary and Confidential

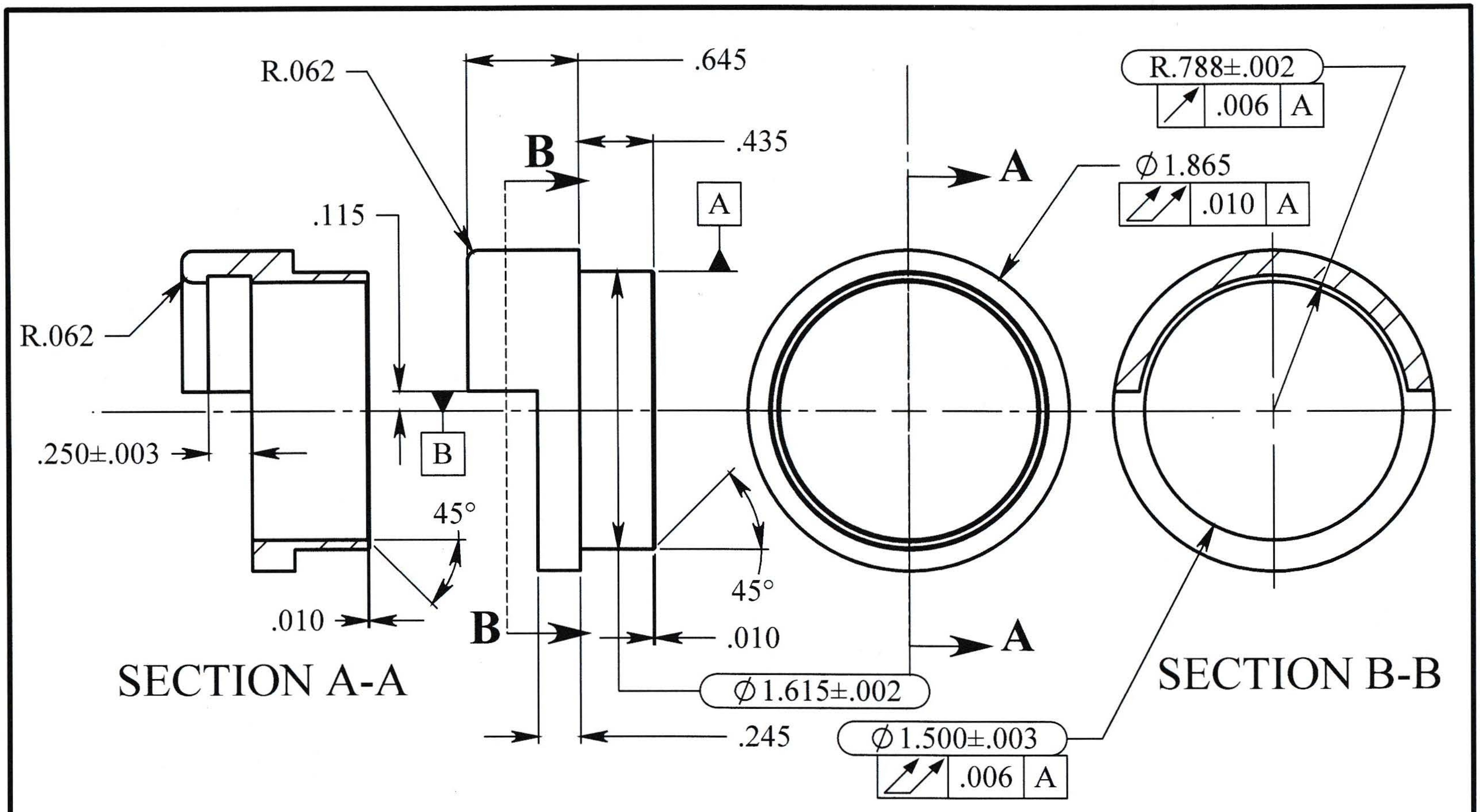
MATERIAL AISI 1095	STEN MK II
HEAT TREAT None	PART NAME Rear Sight Loc Pin
HARDNESS None	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 4:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT None	PART NAME Receiver Rear End Bushing Bottom
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT None	PART NAME Receiver Housing Front Support
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 2:1



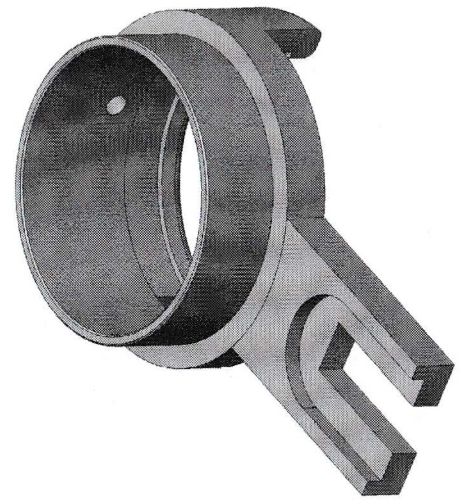
Dimensions are in Inches

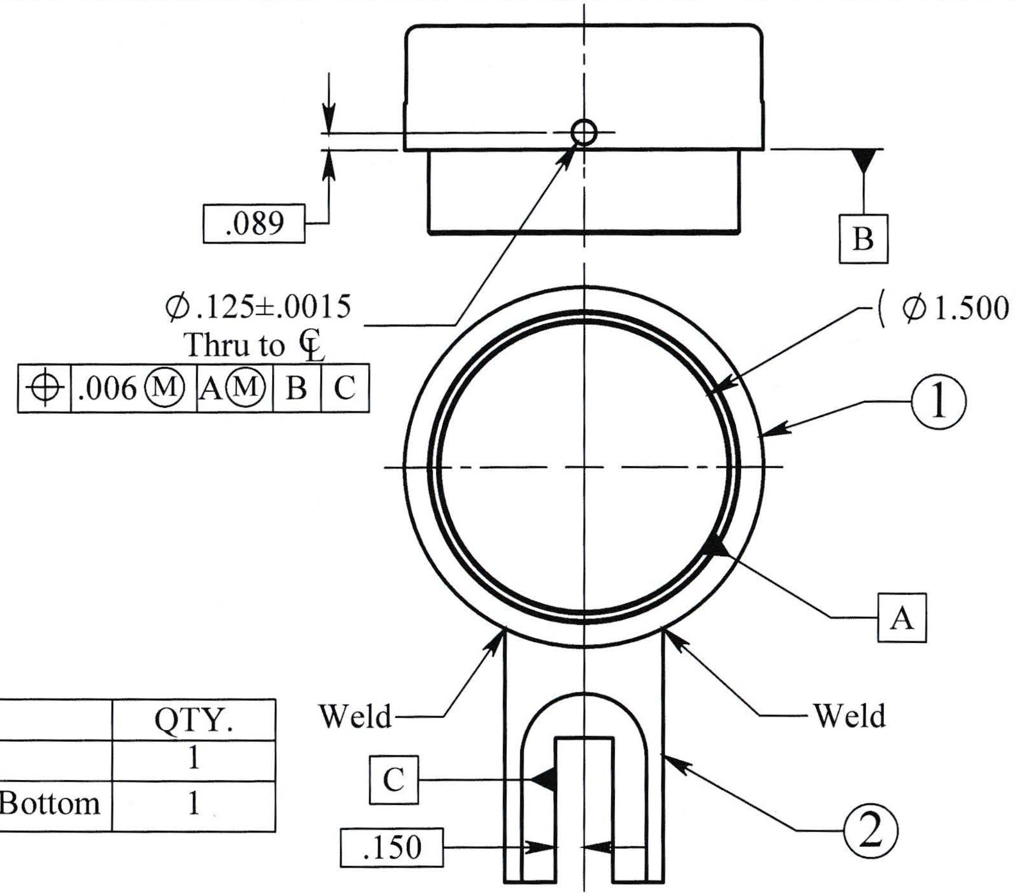
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Receiver Rear End Bushing
HARDNESS HRB 100 Min.	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 1:1





ITEM NO.	PART NUMBER	QTY.
1	Rec. Rear End Bushing	1
2	Rec Rear End Bushing Bottom	1

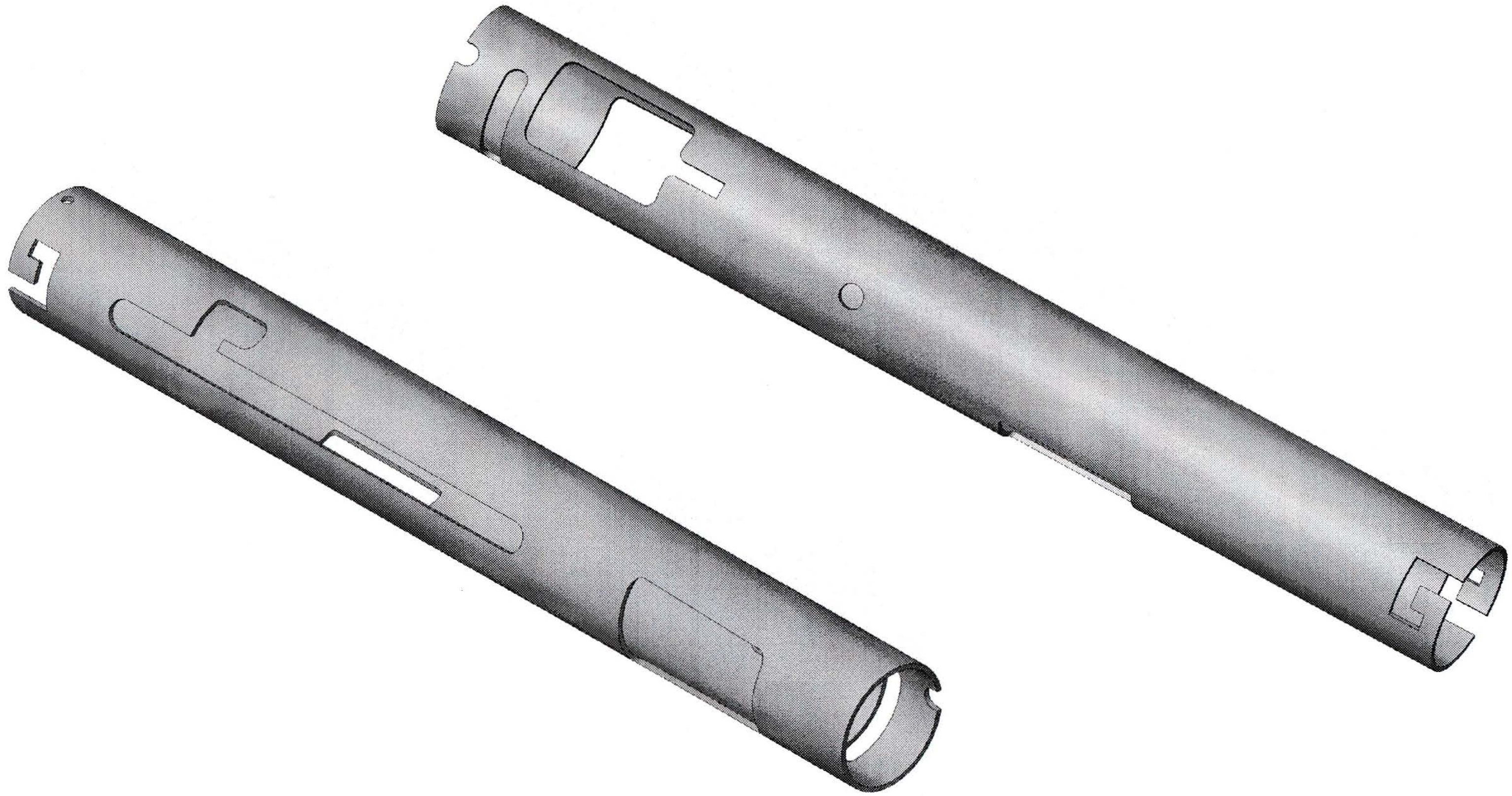
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

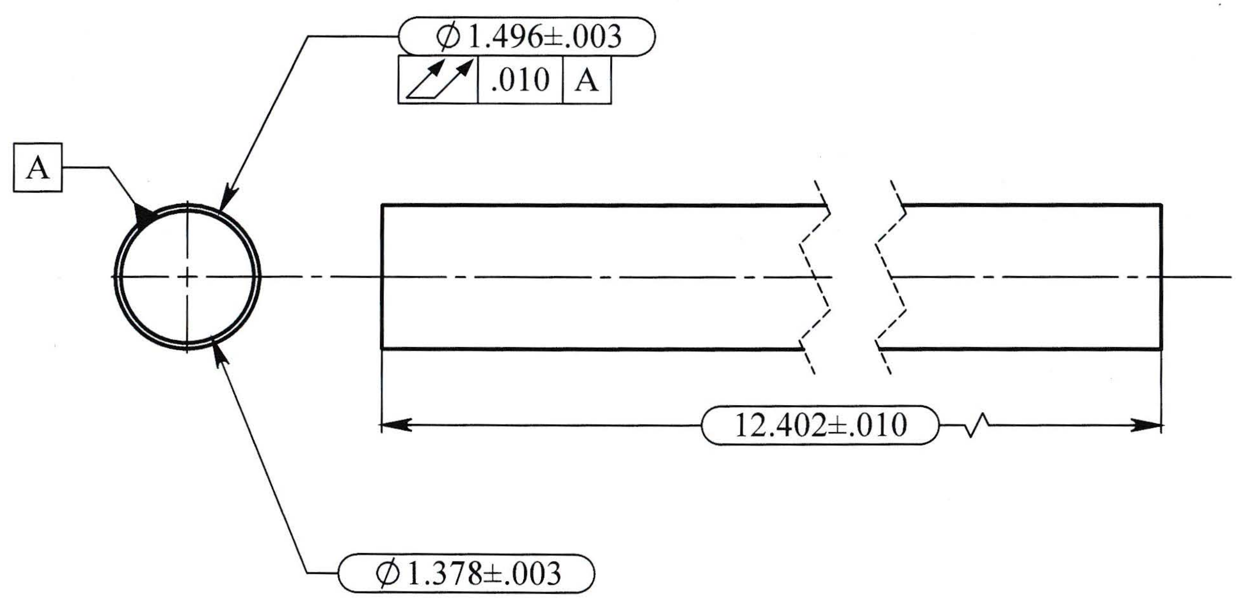
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL	STEN MK II
HEAT TREAT	PART NAME Receiver Rear End Bushing Assembly
HARDNESS	OPERATION NAME Assembly
FINISH	OPERATION NO.
	SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 4130 HEAT TREAT None HARDNESS HRB 100 Min. FINISH None	STEN MK II PART NAME Receiver OPERATION NAME OPERATION NO. SCALE 1:2



Material: Seamless Tubing

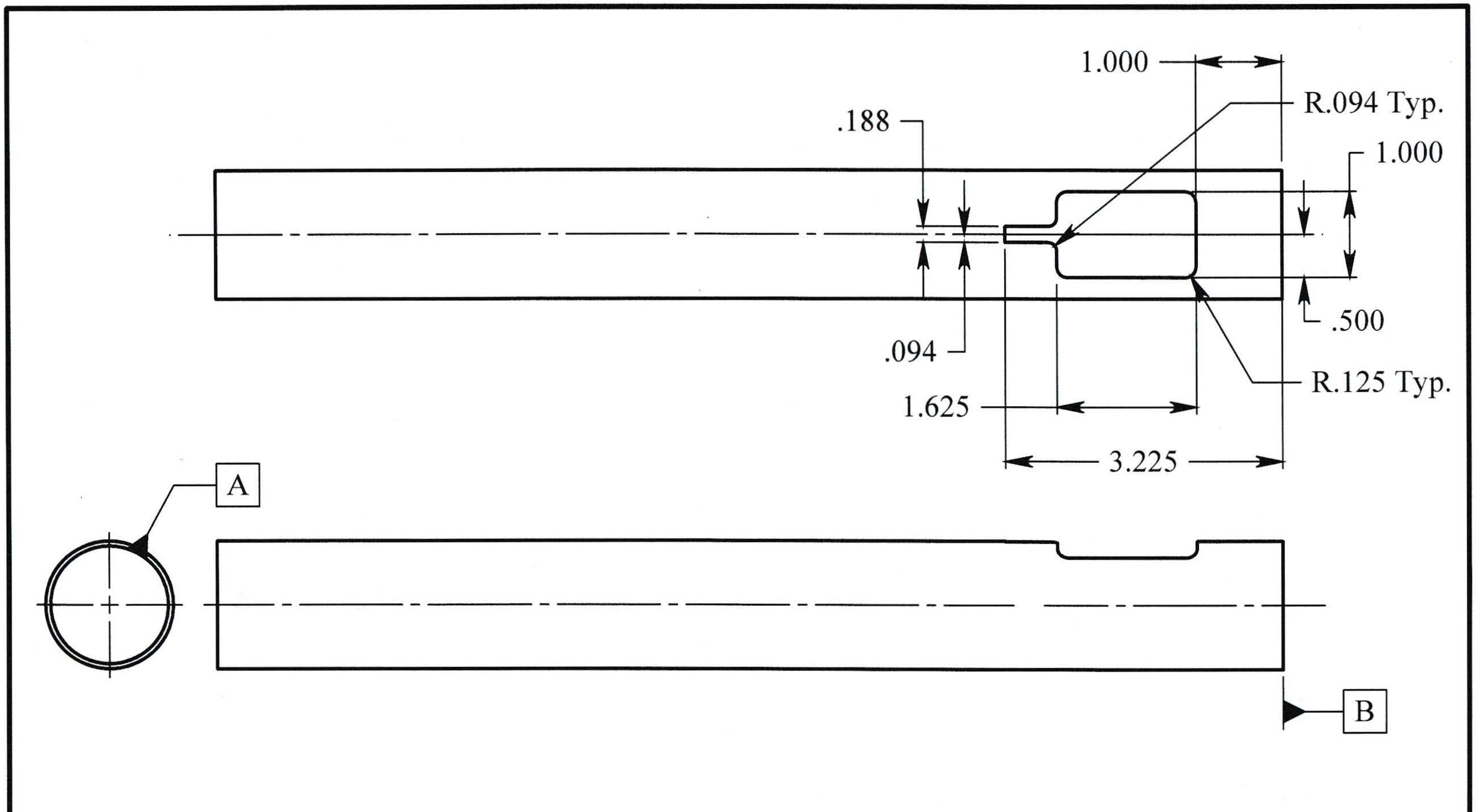
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 4130	STEN MK II
HEAT TREAT None	PART NAME Receiver Blank
HARDNESS HRB 100 Min.	OPERATION NAME Tube Cut Off
FINISH None	OPERATION NO. 10 — SCALE 1:2



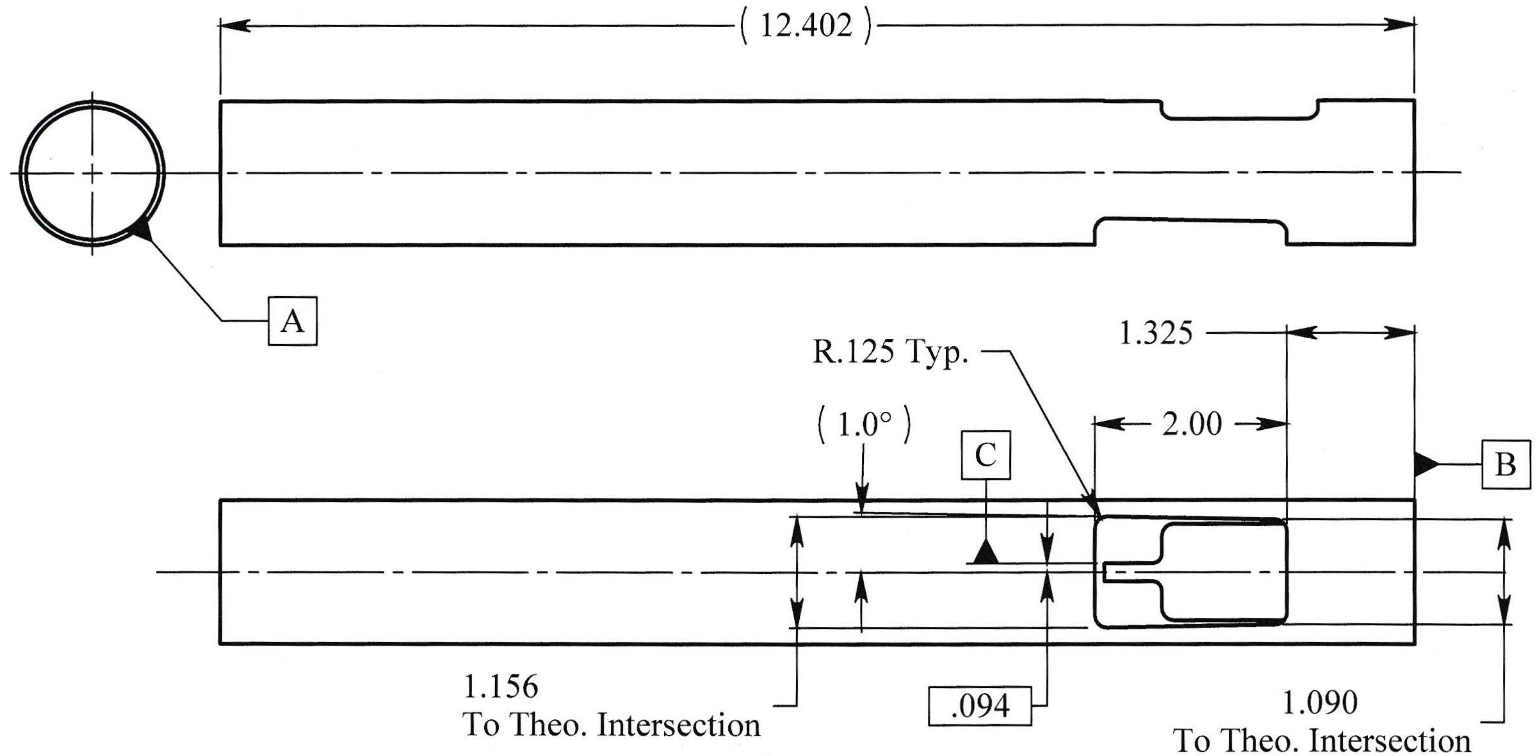
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL AISI 4130 Ref.	STEN MK II
HEAT TREAT	PART NAME Receiver
HARDNESS	OPERATION NAME Magazine Opening
FINISH	OPERATION NO. 20 — SCALE 1:2



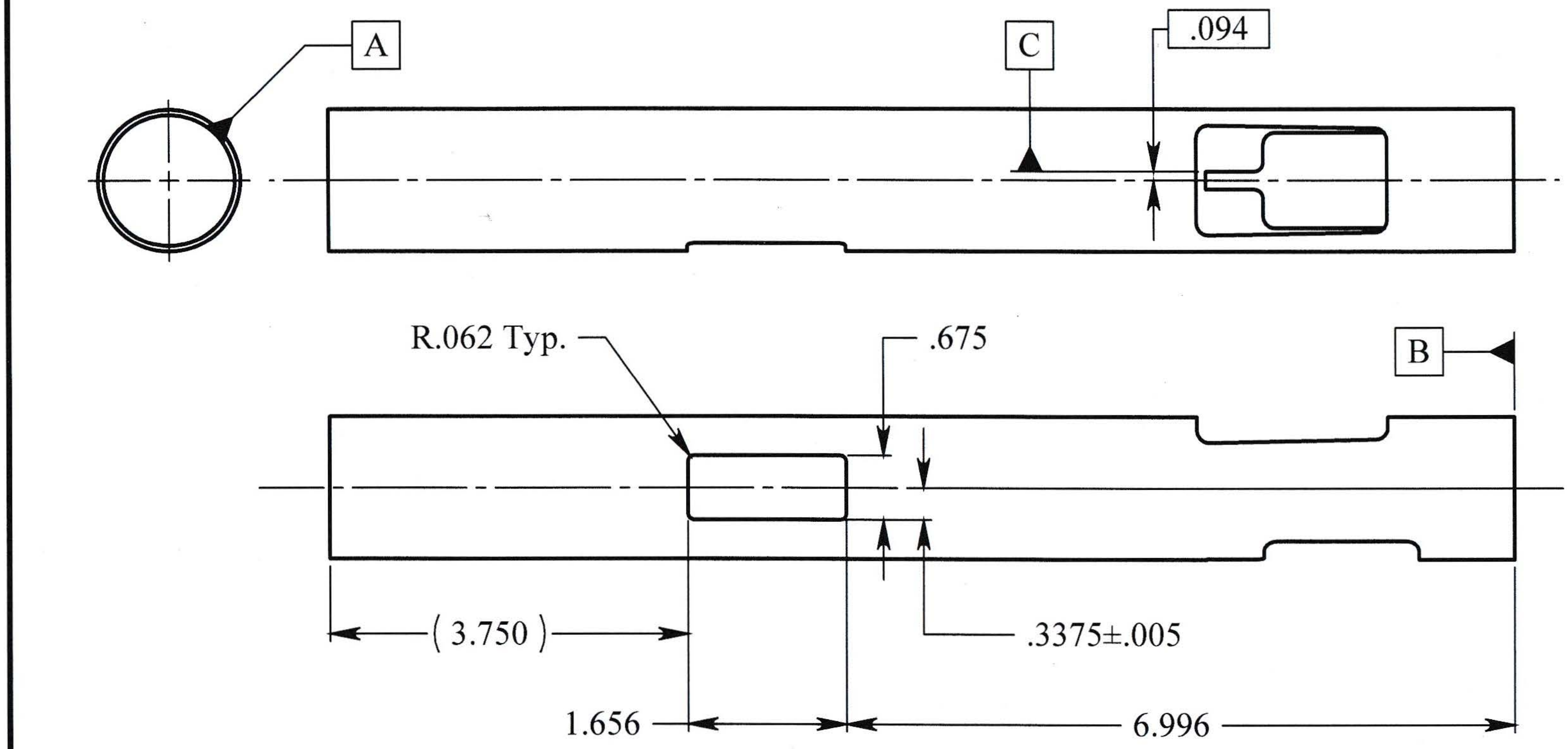
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

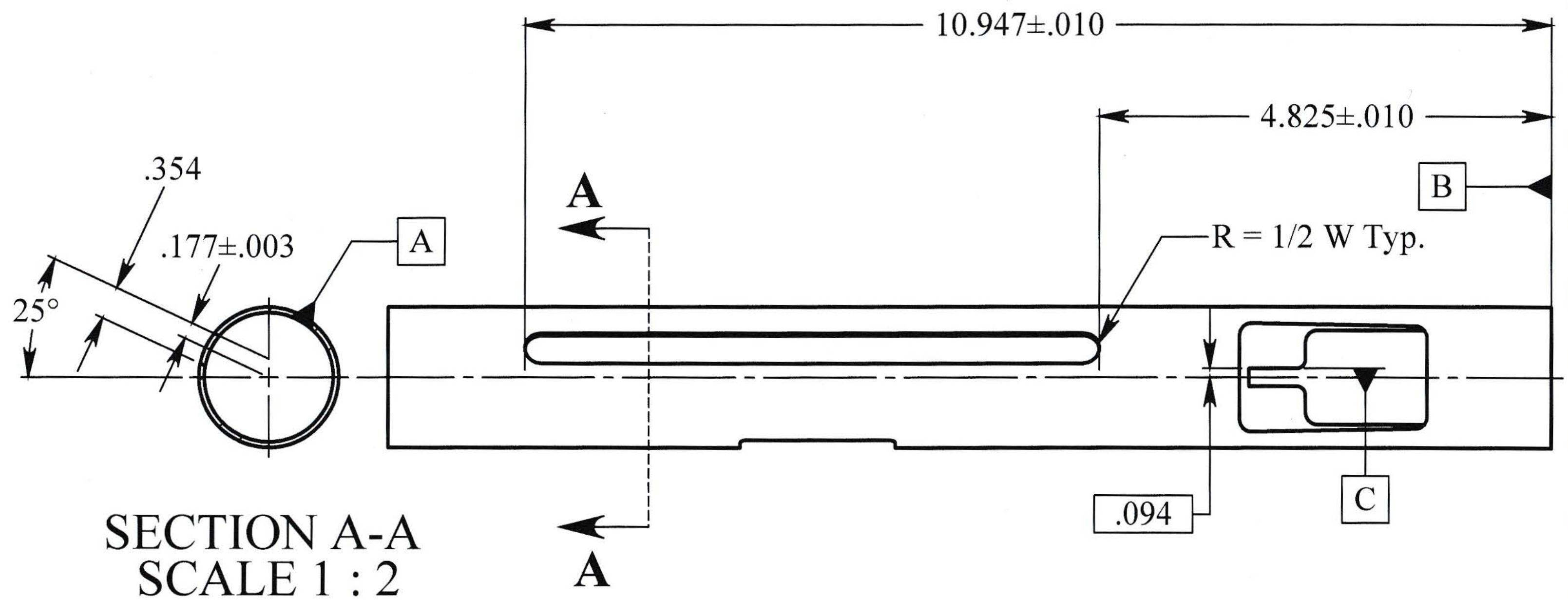
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 4130 Ref.	STEN MK II
HEAT TREAT	PART NAME Receiver
HARDNESS	OPERATION NAME Ejection Port
FINISH	OPERATION NO. 30 — SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 4130 Ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Receiver OPERATION NAME Sear Opening OPERATION NO. 40 SCALE 1:2



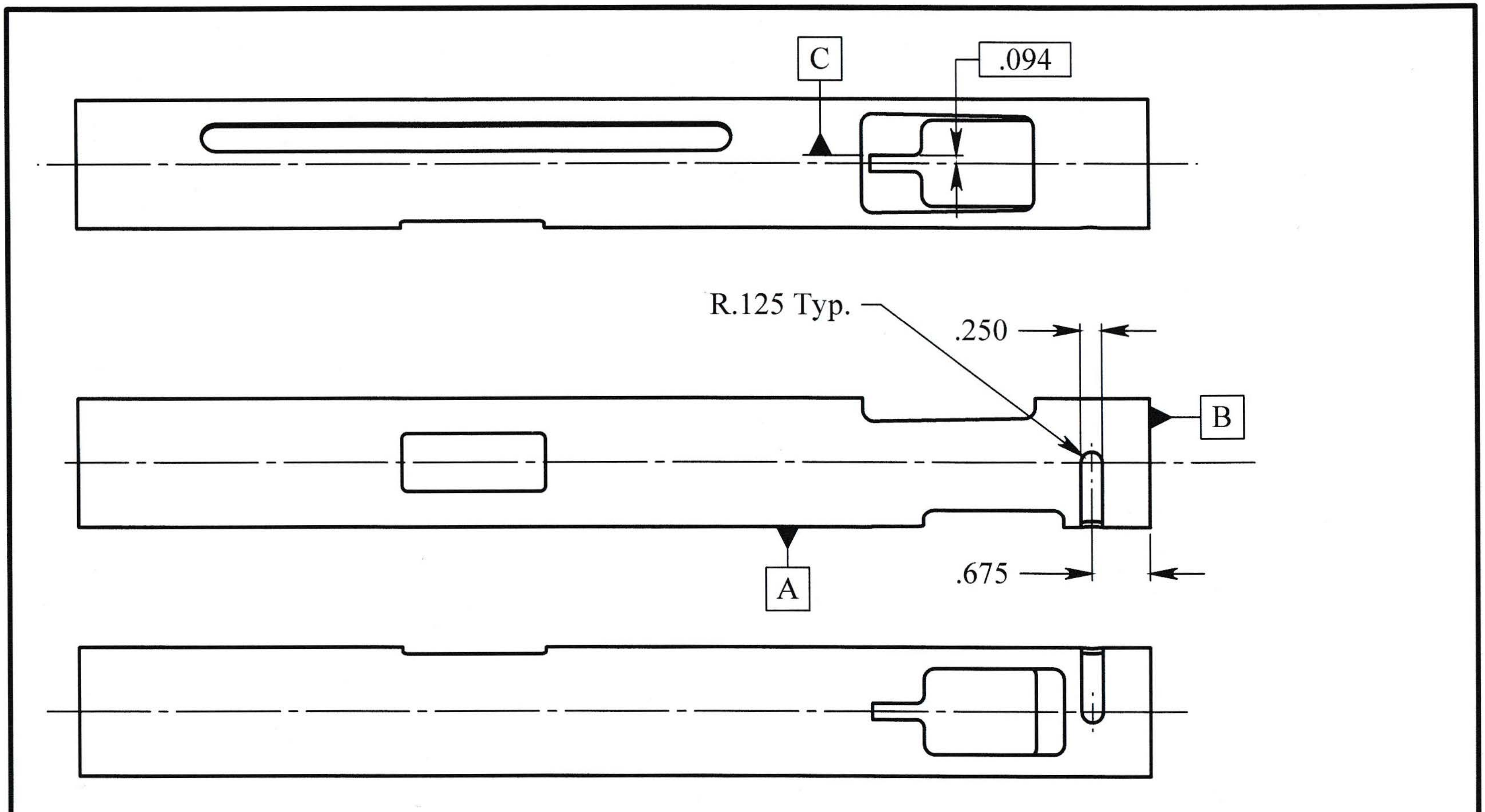
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 4130 Ref.	STEN MK II
HEAT TREAT	PART NAME Receiver
HARDNESS	OPERATION NAME Operating Handle
FINISH	OPERATION NO. 50 — SCALE 1:2



Dimensions are in Inches

Tolerances:

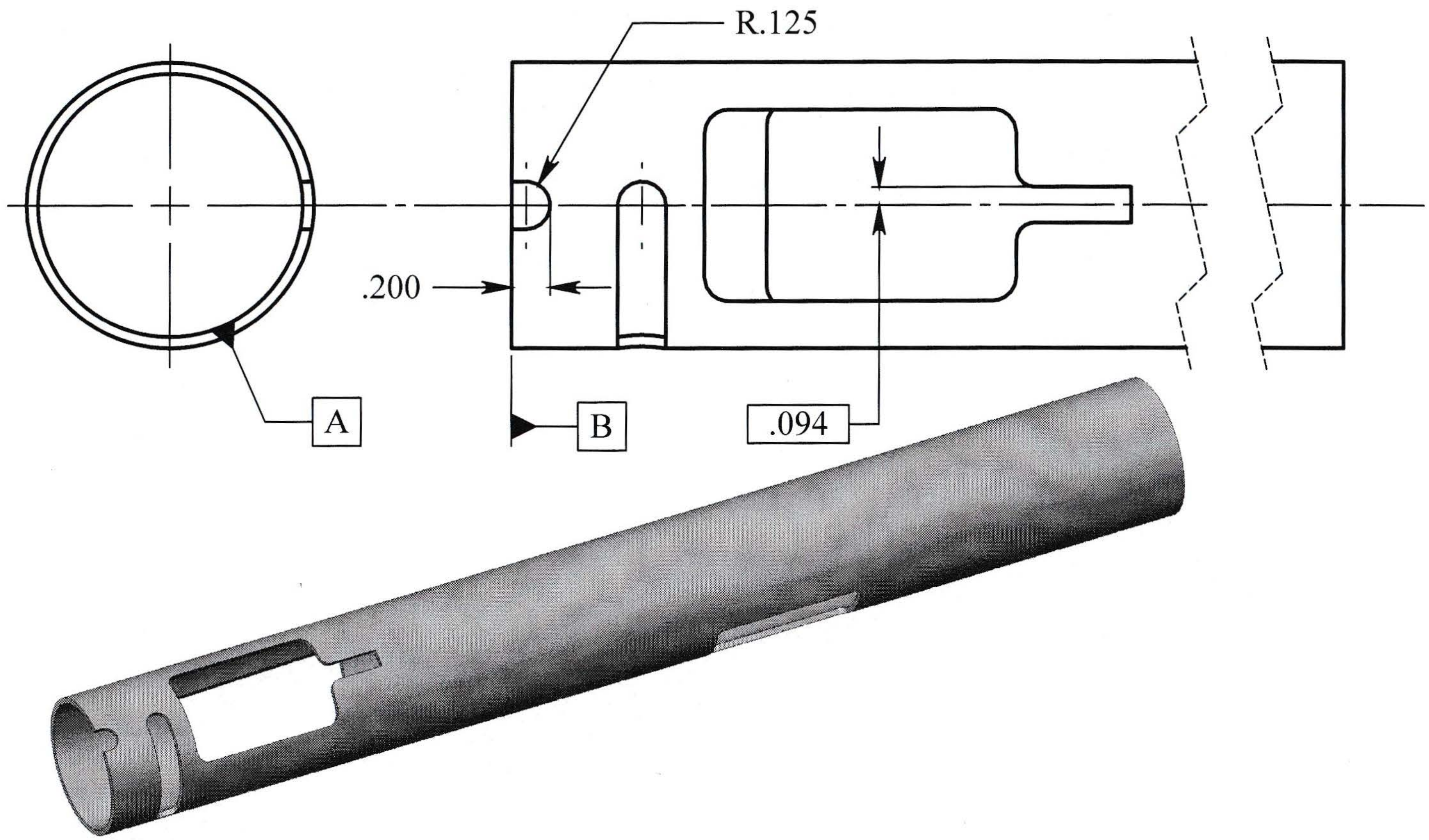
Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:

1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL: AISI 4130 Ref.	STEN MK II
HEAT TREAT:	PART NAME: Receiver
HARDNESS:	OPERATION NAME: Front Slot
FINISH:	OPERATION NO.: 60 — SCALE: 1:2



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
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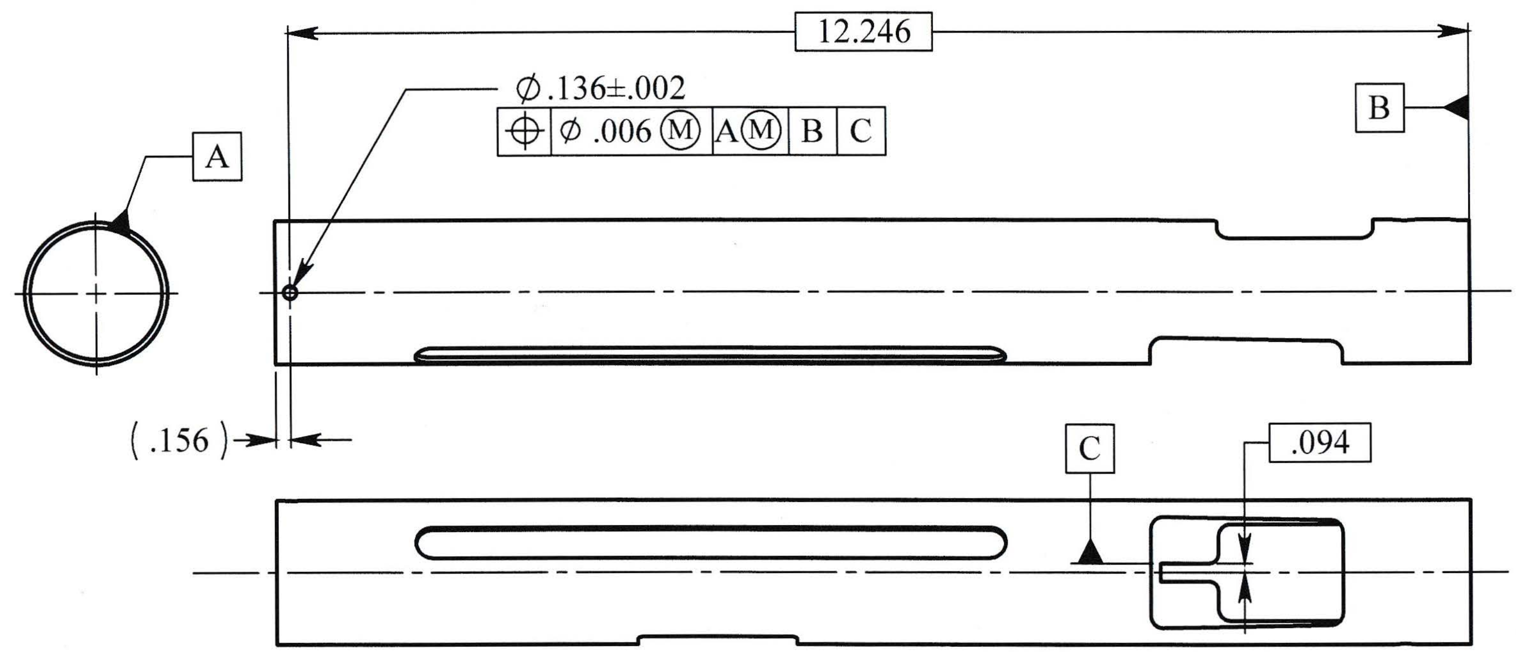
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL AISI 4130 Ref.	STEN MK II		
HEAT TREAT	PART NAME Receiver		
HARDNESS	OPERATION NAME Index Slot		
FINISH	OPERATION NO. 70	SCALE 1:1	



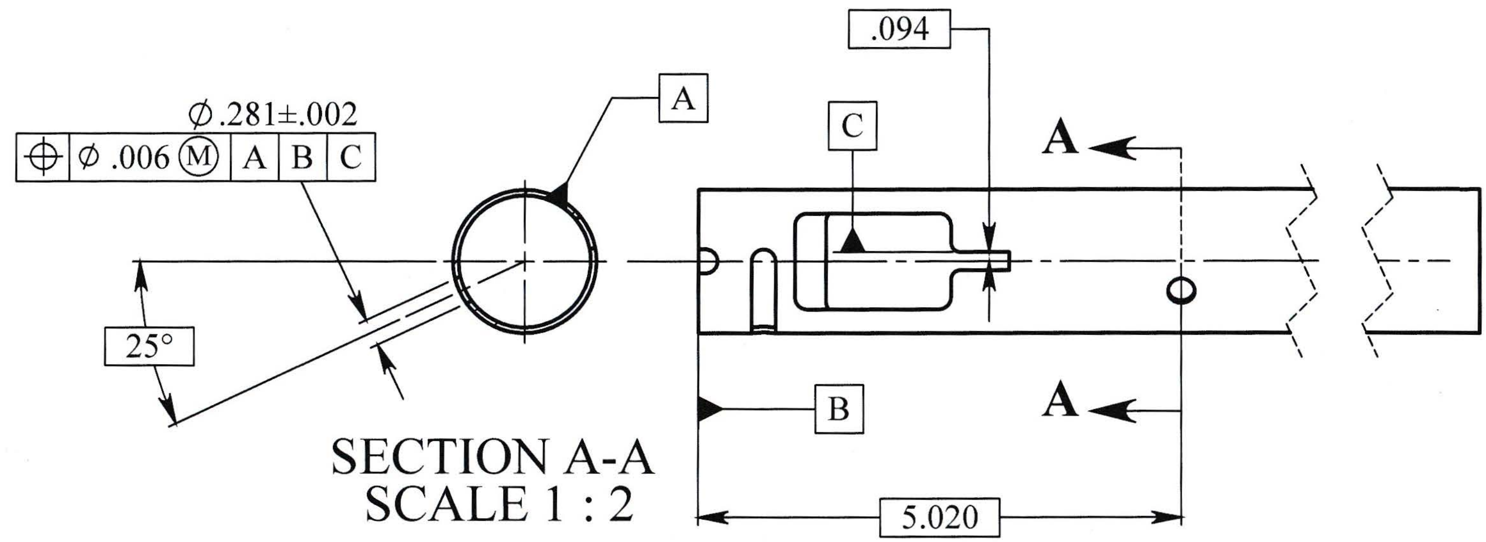
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance →| |← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |← C .XXX

Proprietary and Confidential

MATERIAL AISI 4130 Ref.	STEN MK II
HEAT TREAT	PART NAME Receiver
HARDNESS	OPERATION NAME Rear Sight Hole
FINISH	OPERATION NO. 80 — SCALE 1:2



SECTION A-A
SCALE 1 : 2

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
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2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL
AISI 4130 Ref.

HEAT TREAT

HARDNESS

FINISH

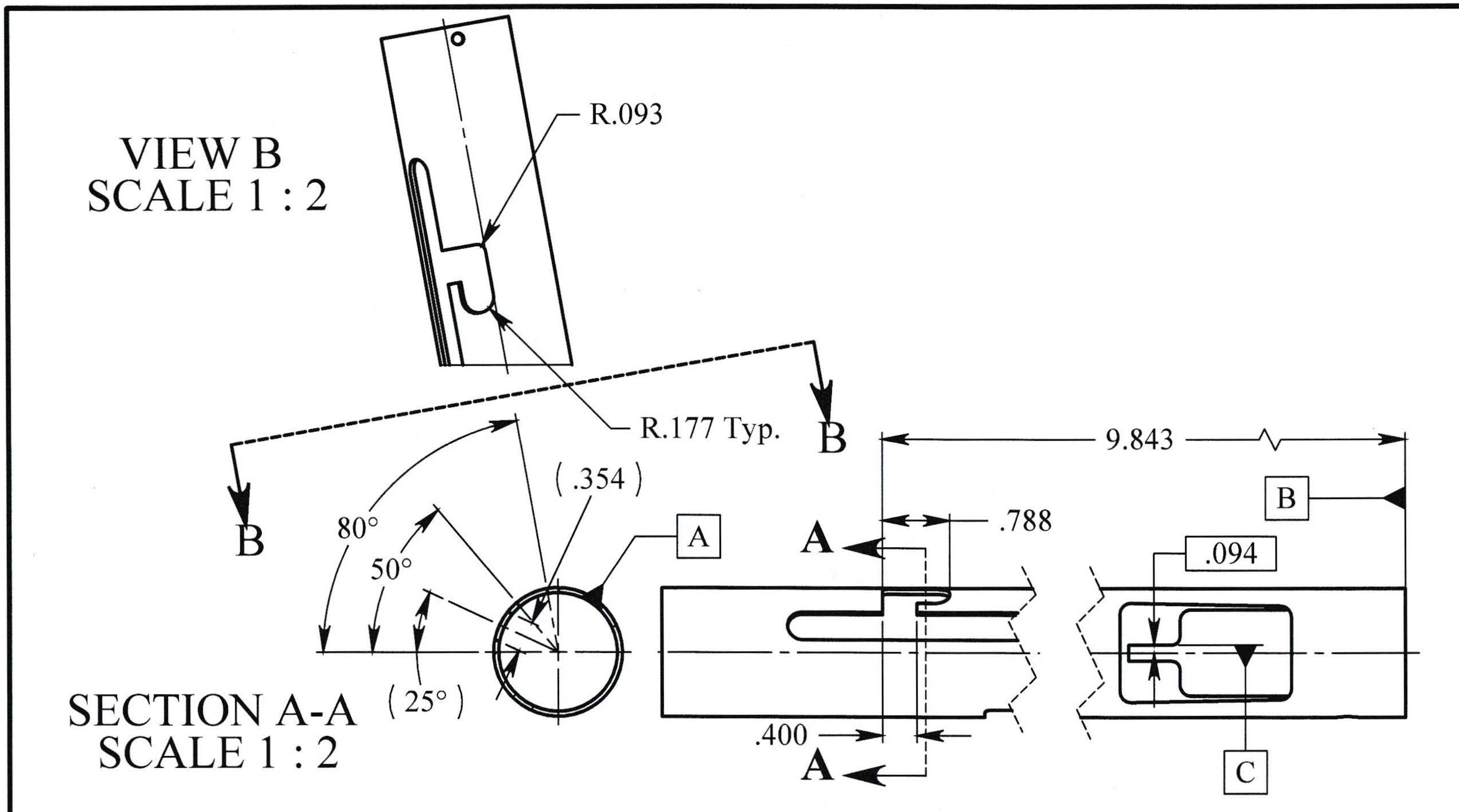
STEN MK II

PART NAME
Receiver

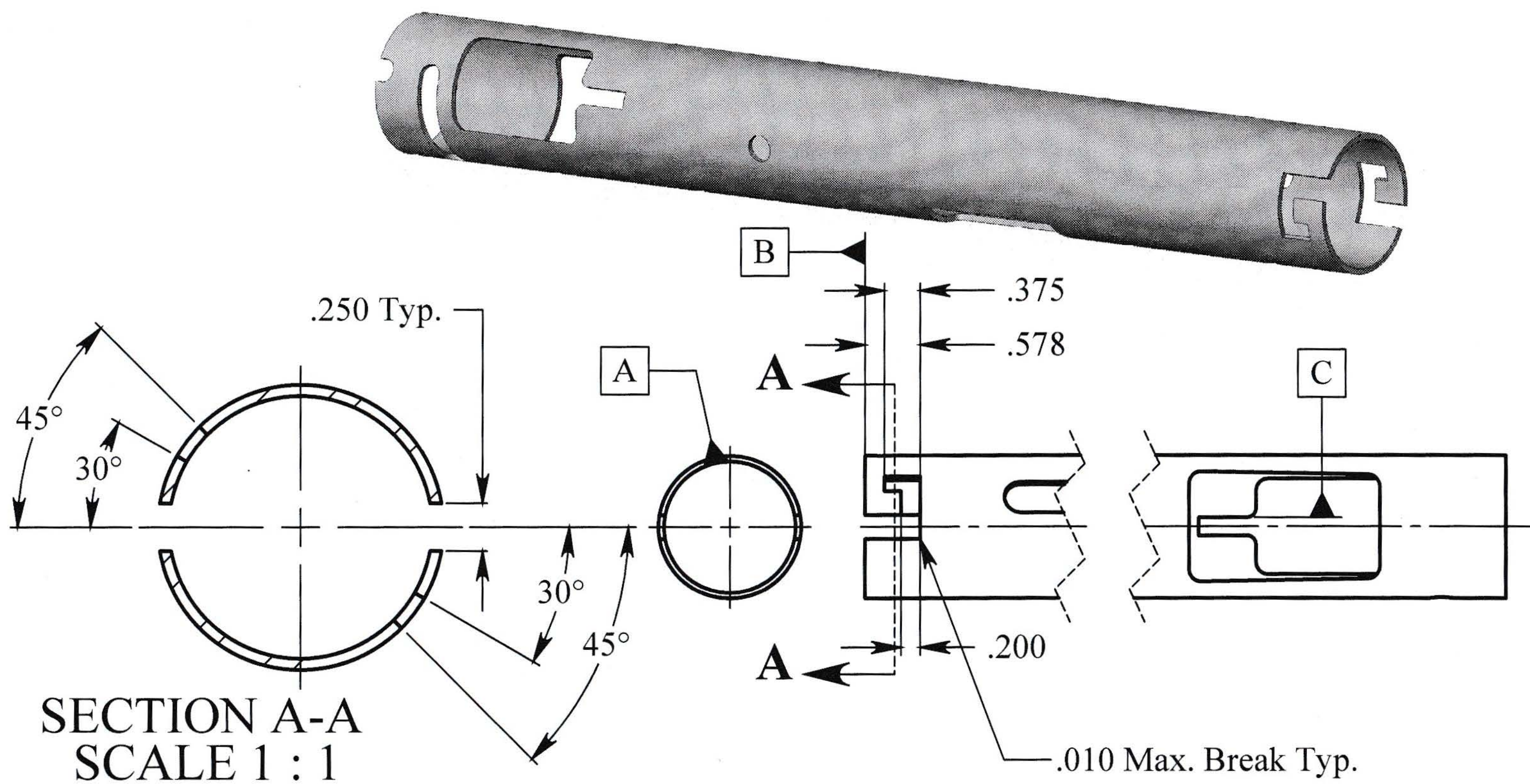
OPERATION NAME
Oper. Handle Lock Hole

OPERATION NO.
90

SCALE
1:2

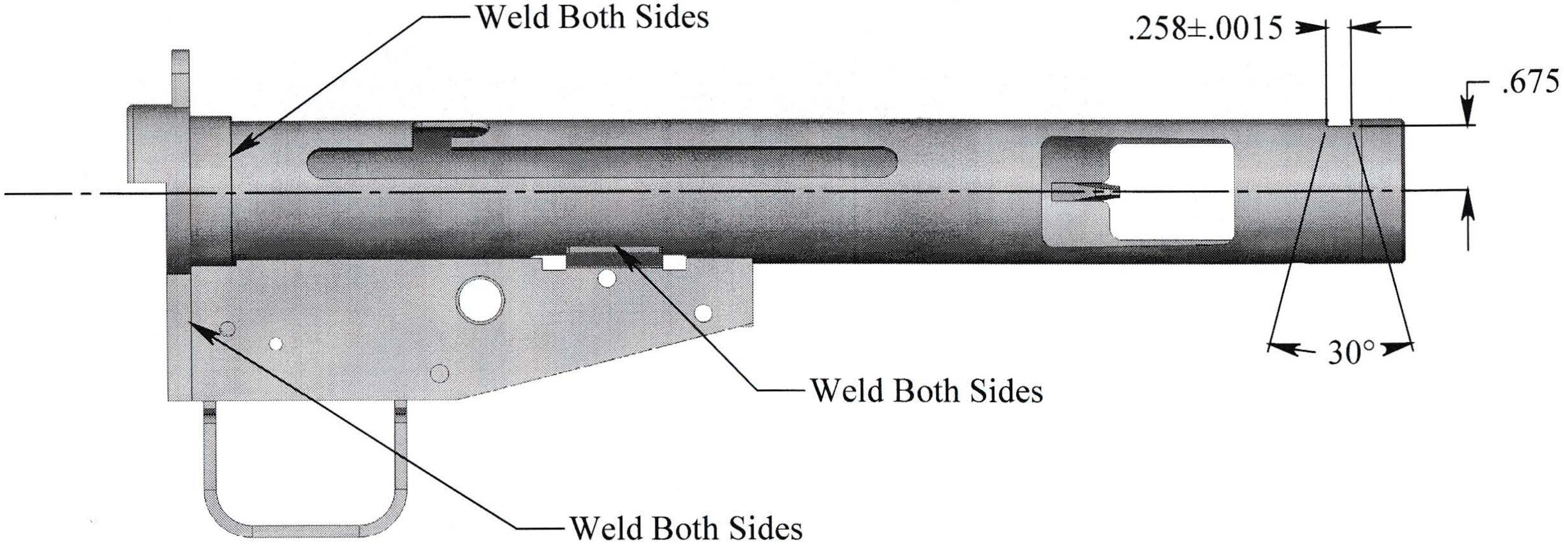


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 4130 Ref. HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Receiver OPERATION NAME Operating Handle Rear Lock Cut OPERATION NO. 100 — SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 4130 HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Receiver OPERATION NAME Spring Cap Retaining Cuts OPERATION NO. 110 — SCALE 1:2

Proprietary and Confidential



ITEM NO.	PART NUMBER	QTY.
1	Receiver Bottom Sub-Assembly	1
2	Receiver Top Sub-Assembly	1

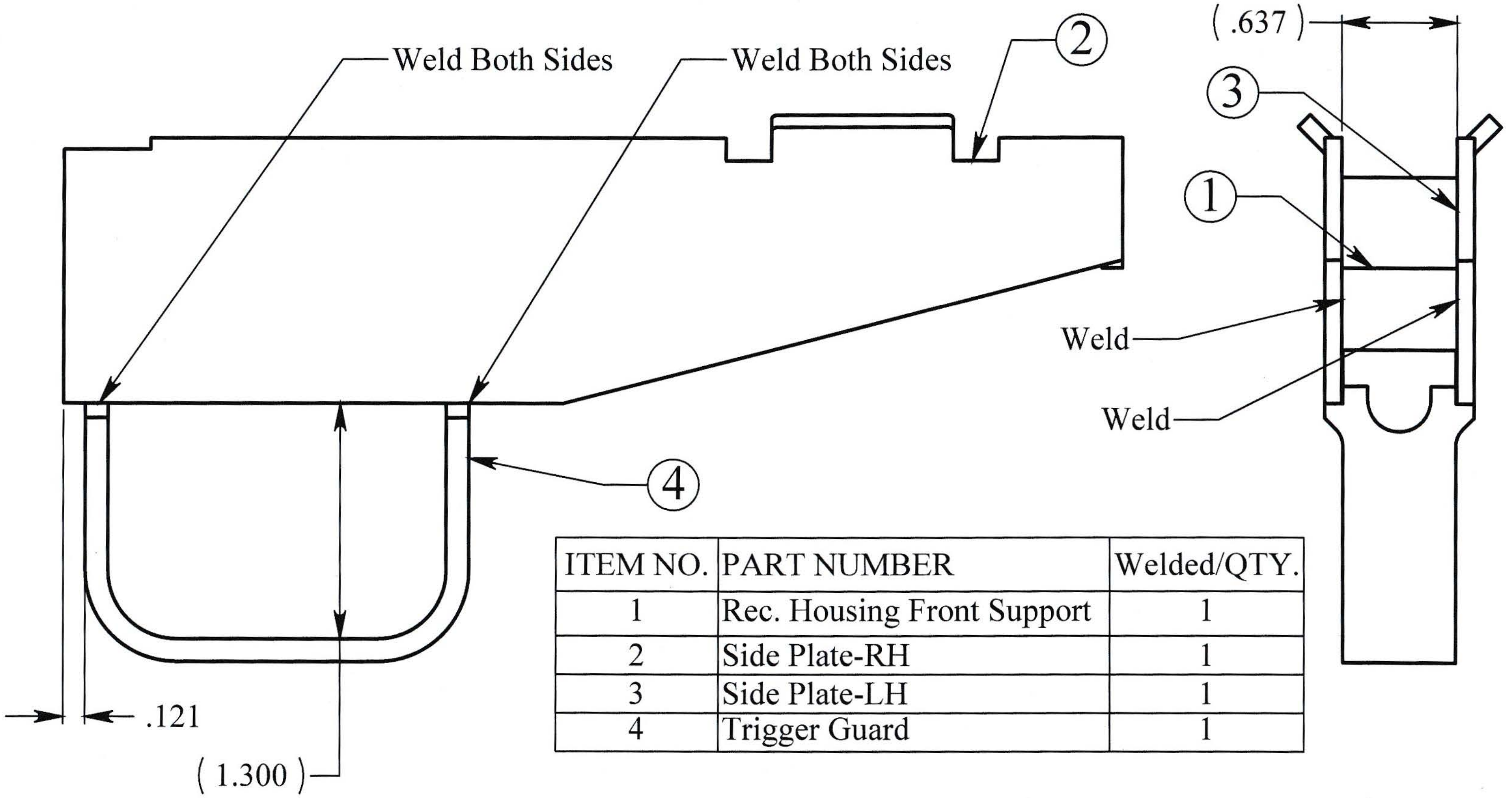
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL	STEN MK II
HEAT TREAT	PART NAME Receiver Assy Complete
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 3:2



ITEM NO.	PART NUMBER	Welded/QTY.
1	Rec. Housing Front Support	1
2	Side Plate-RH	1
3	Side Plate-LH	1
4	Trigger Guard	1

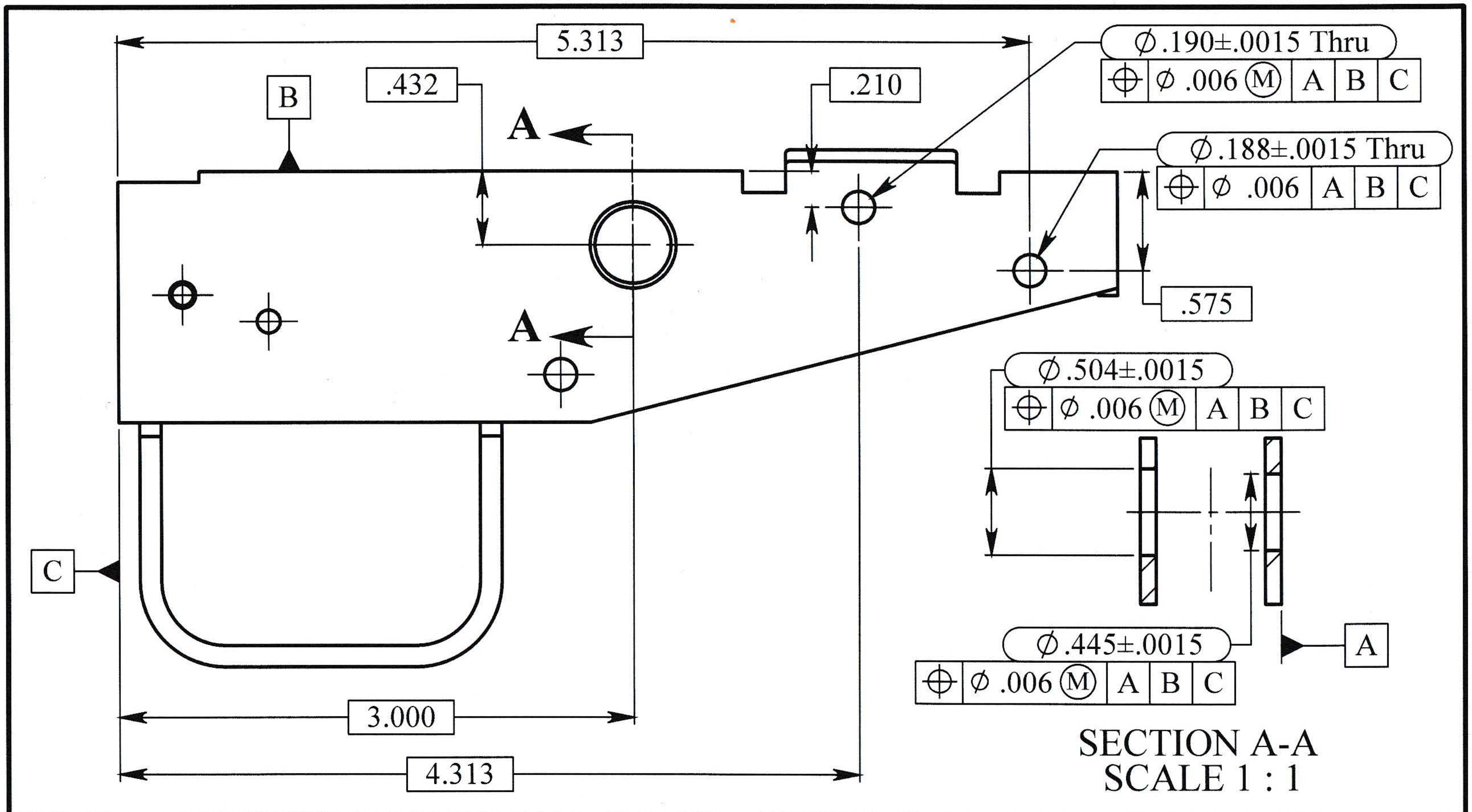
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

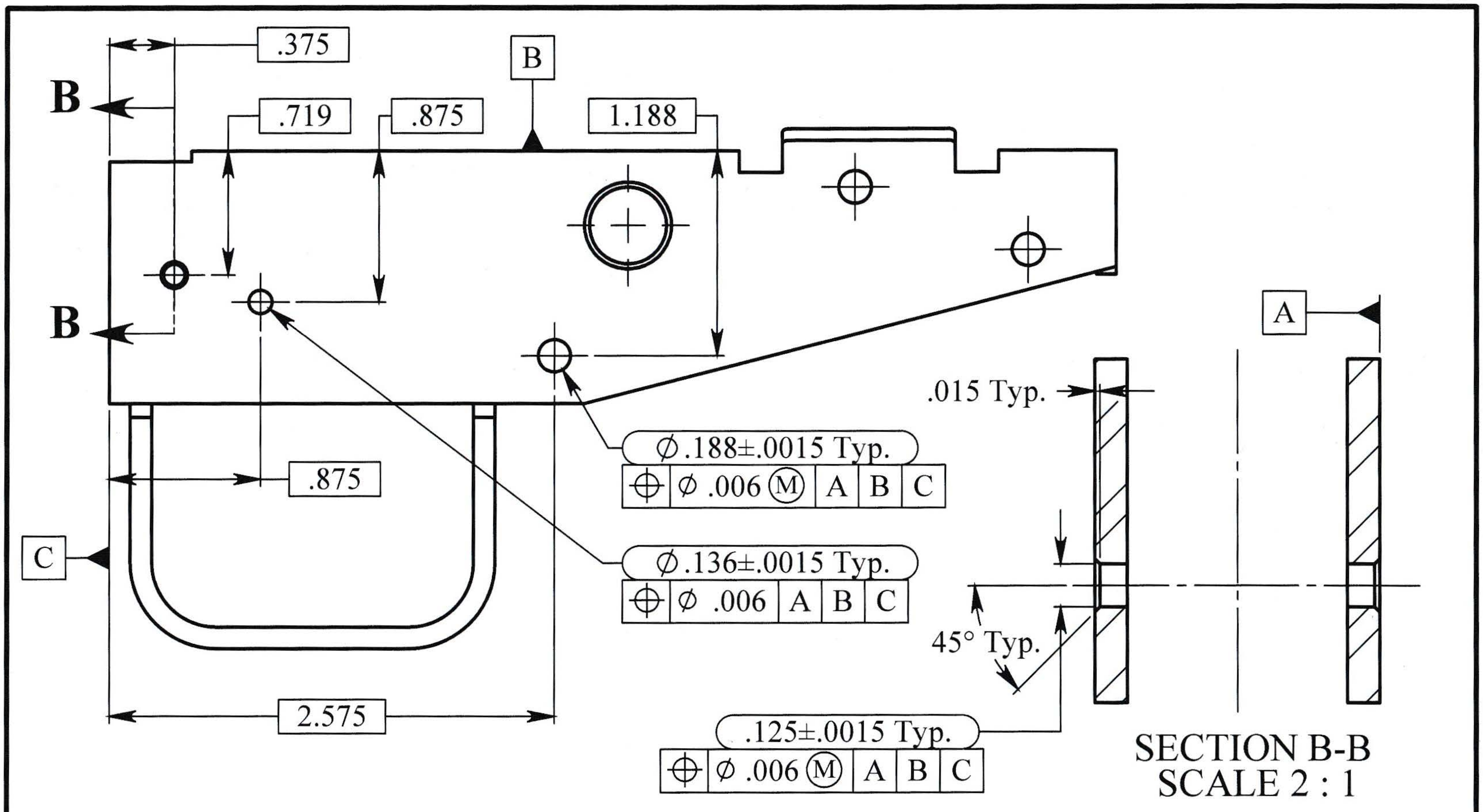
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL	STEN MK II
HEAT TREAT	PART NAME Receiver Bottom Sub-Assembly
HARDNESS	OPERATION NAME Welding
FINISH	OPERATION NO. 10 / SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Receiver Bottom Sub-Assembly OPERATION NAME Holes OPERATION NO. 20 — SCALE 1:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

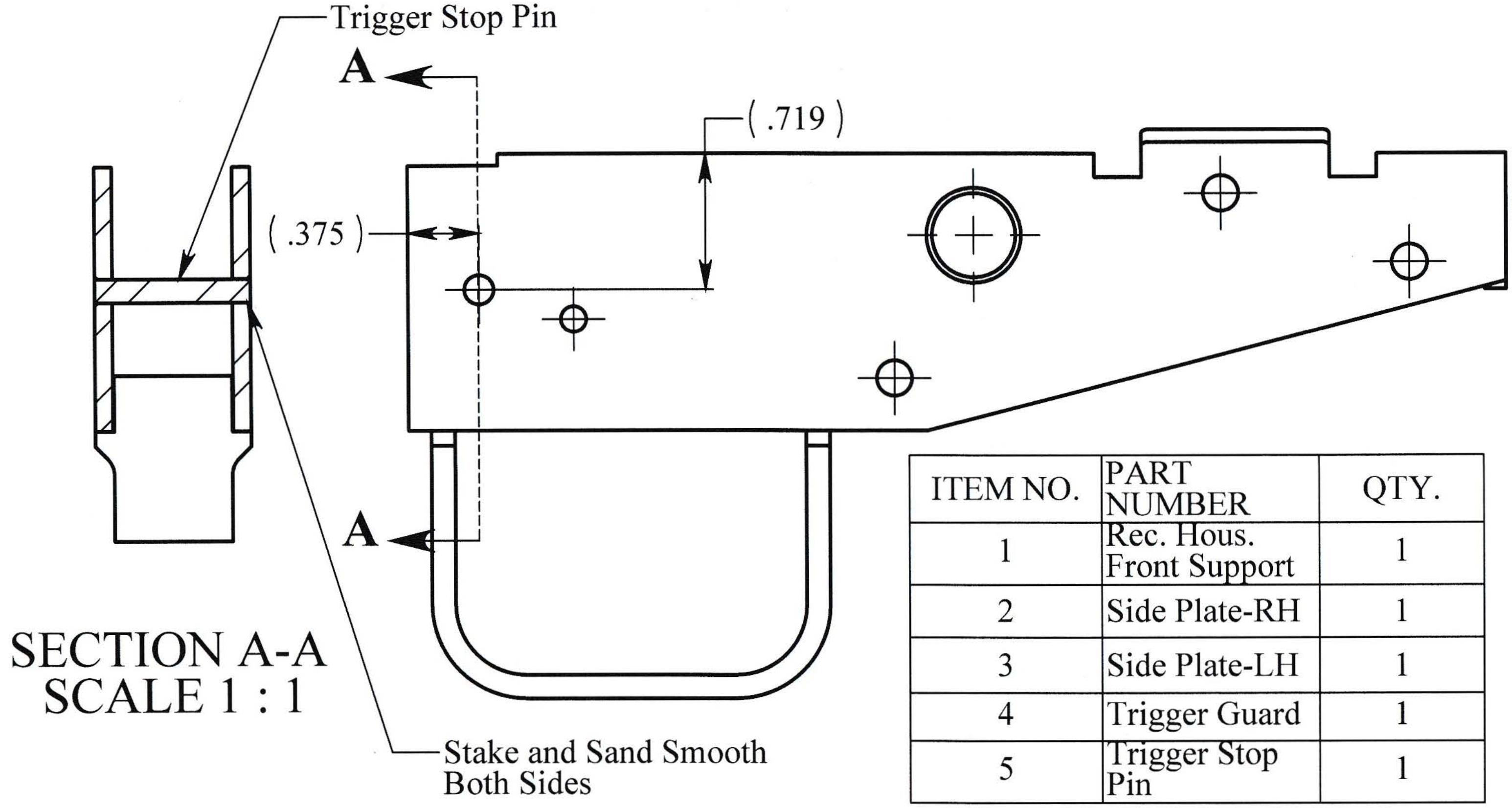
STEN MK II

PART NAME Receiver Bottom Sub-Assembly

OPERATION NAME Holes

OPERATION NO. 30

SCALE 1:1



SECTION A-A
SCALE 1 : 1

ITEM NO.	PART NUMBER	QTY.
1	Rec. Hous. Front Support	1
2	Side Plate-RH	1
3	Side Plate-LH	1
4	Trigger Guard	1
5	Trigger Stop Pin	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

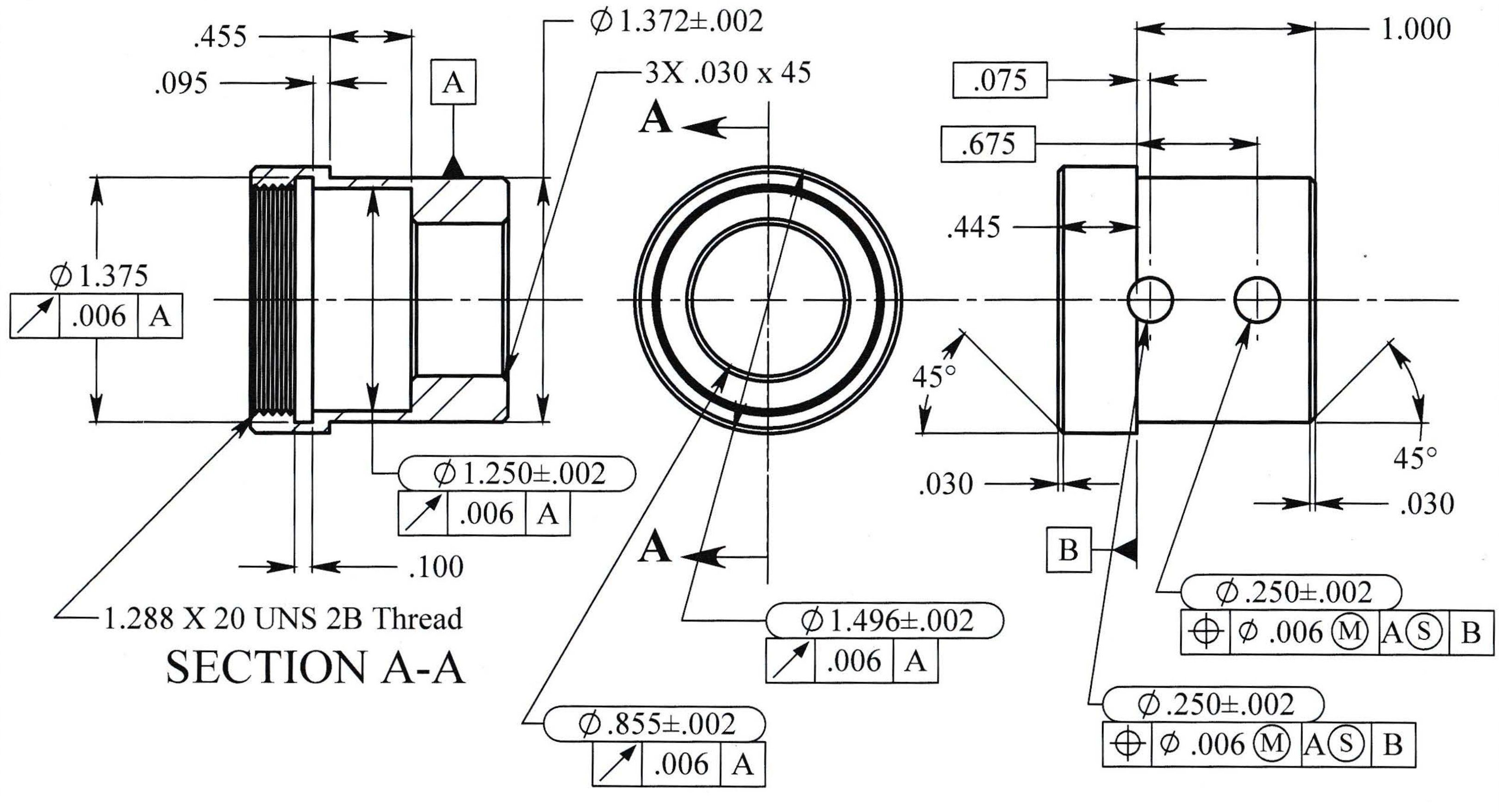
STEN MK II

PART NAME Receiver Bottom Sub-Assembly

OPERATION NAME Assemble Trigger Stop Pin

OPERATION NO. 40

SCALE 1:1



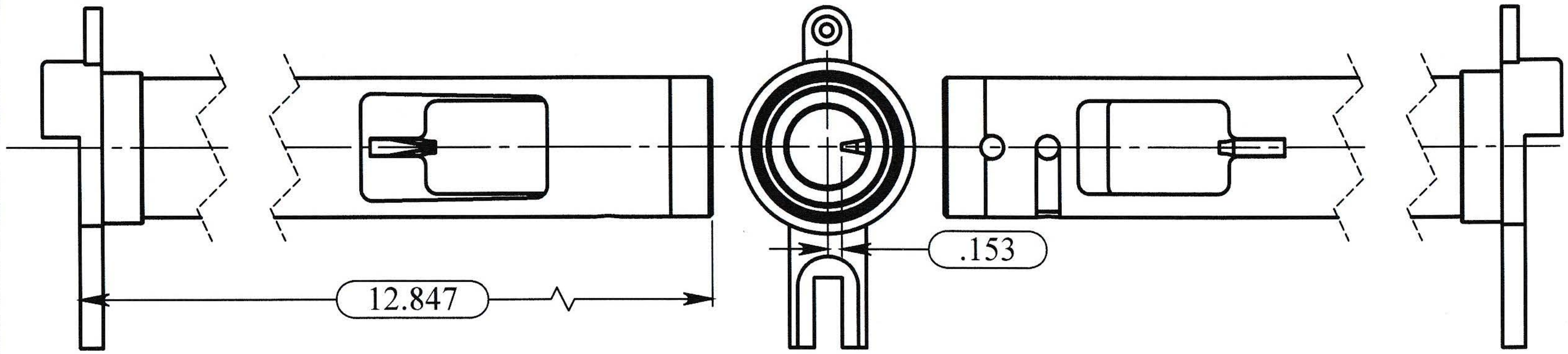
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

MATERIAL AISI 4137	STEN MK II
HEAT TREAT Quench &Temper	PART NAME Receiver Bushing
HARDNESS HRC 40 - 45	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 1:1

Proprietary and Confidential



ITEM NO.	PART NUMBER	QTY.
1	Receiver	1
2	Receiver Bushing	1
3	Rear Sight	1
4	Rear Sight Loc Pin	1
5	Ejector	1
6	Rec. Rear End Bushing Assy	1

Weld All Components Together

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance →| |←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |←(C .XXX)

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

STEN MK II

PART NAME Receiver Top Sub-Assembly

OPERATION NAME

OPERATION NO.

SCALE 1:2

Manufacturing Data:

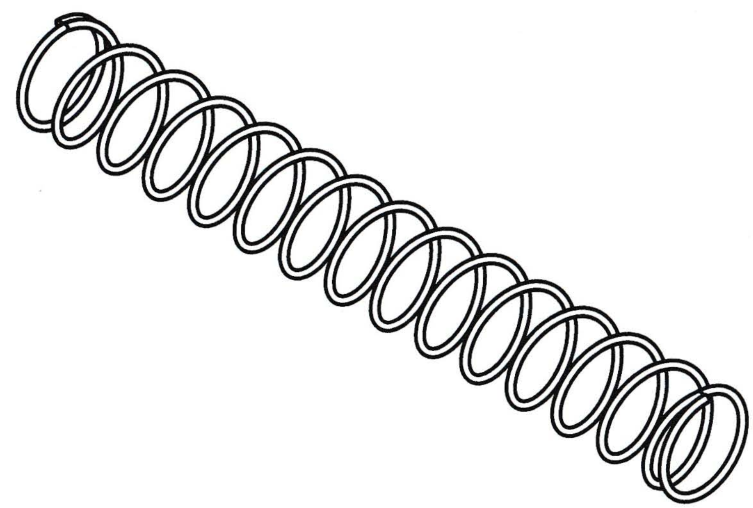
Spring Type:	Helical Compression
Outside Diameter:	1.043 inches
Wire Diameter:	.063
Total Coils:	17.0
Active Coils:	15.0
Coil Type:	Closed, Not Ground
Free Length:	9.646
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	6.000 inches
Load P1:	5.85 +/-1.2 lbs.
Load Length L2:	3.000 inches
Load P2:	10.66 lbs +/-1.3 lbs.
Max. Solid Height:	1.200 inches
Spring works over:	.850 diameter rod

Engineering Data:

Spring Rate:	1.60 lbs/in.
Spring Index:	15.6
Static Solid Stress:	148,700 psi
Stress Percentage: at Solid Height	50.7%



Dimensions are in Inches

Tolerances:

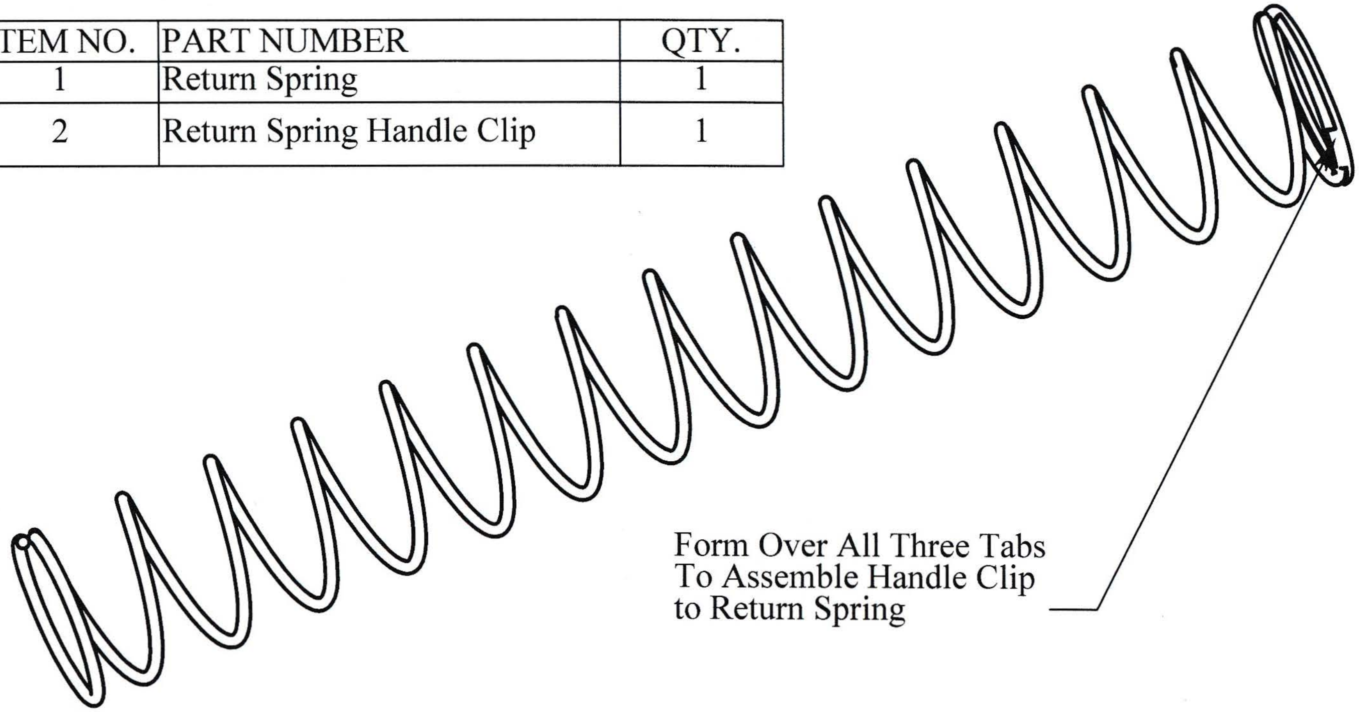
Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

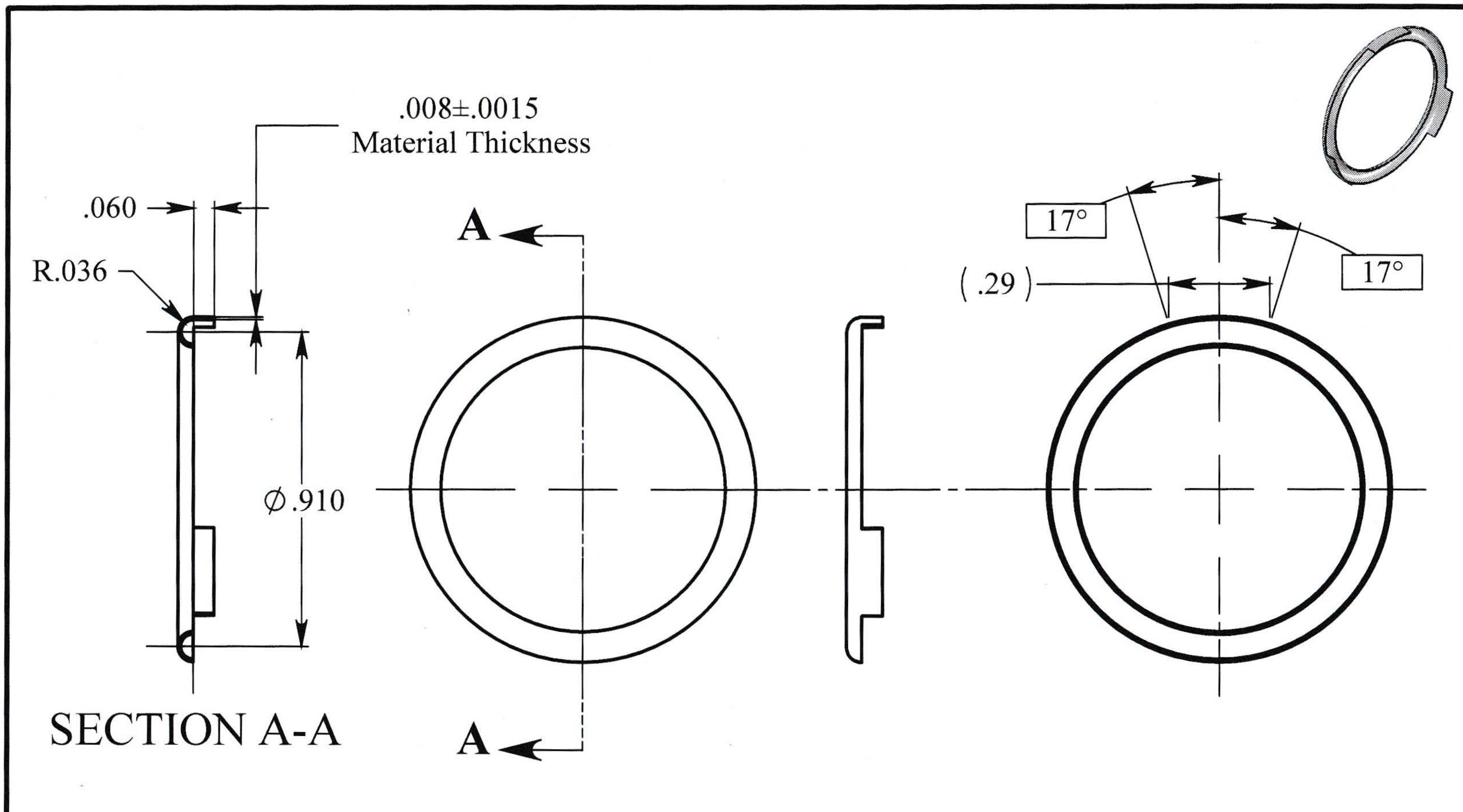
Proprietary and Confidential

MATERIAL: Music Wire (ASTM A228)	STEN MK II
HEAT TREAT: Stress Relieve	PART NAME: Return Spring
HARDNESS:	OPERATION NAME:
FINISH: Oiled	OPERATION NO.: / SCALE: 3:2

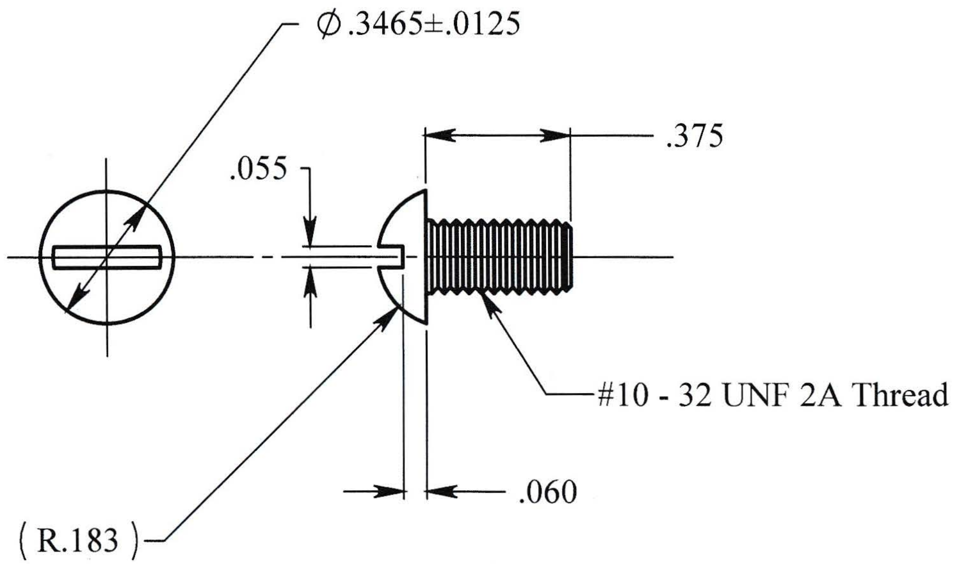
ITEM NO.	PART NUMBER	QTY.
1	Return Spring	1
2	Return Spring Handle Clip	1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance →| |← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |← C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	STEN MK II PART NAME Return Spring Assy OPERATION NAME OPERATION NO. SCALE 1:1

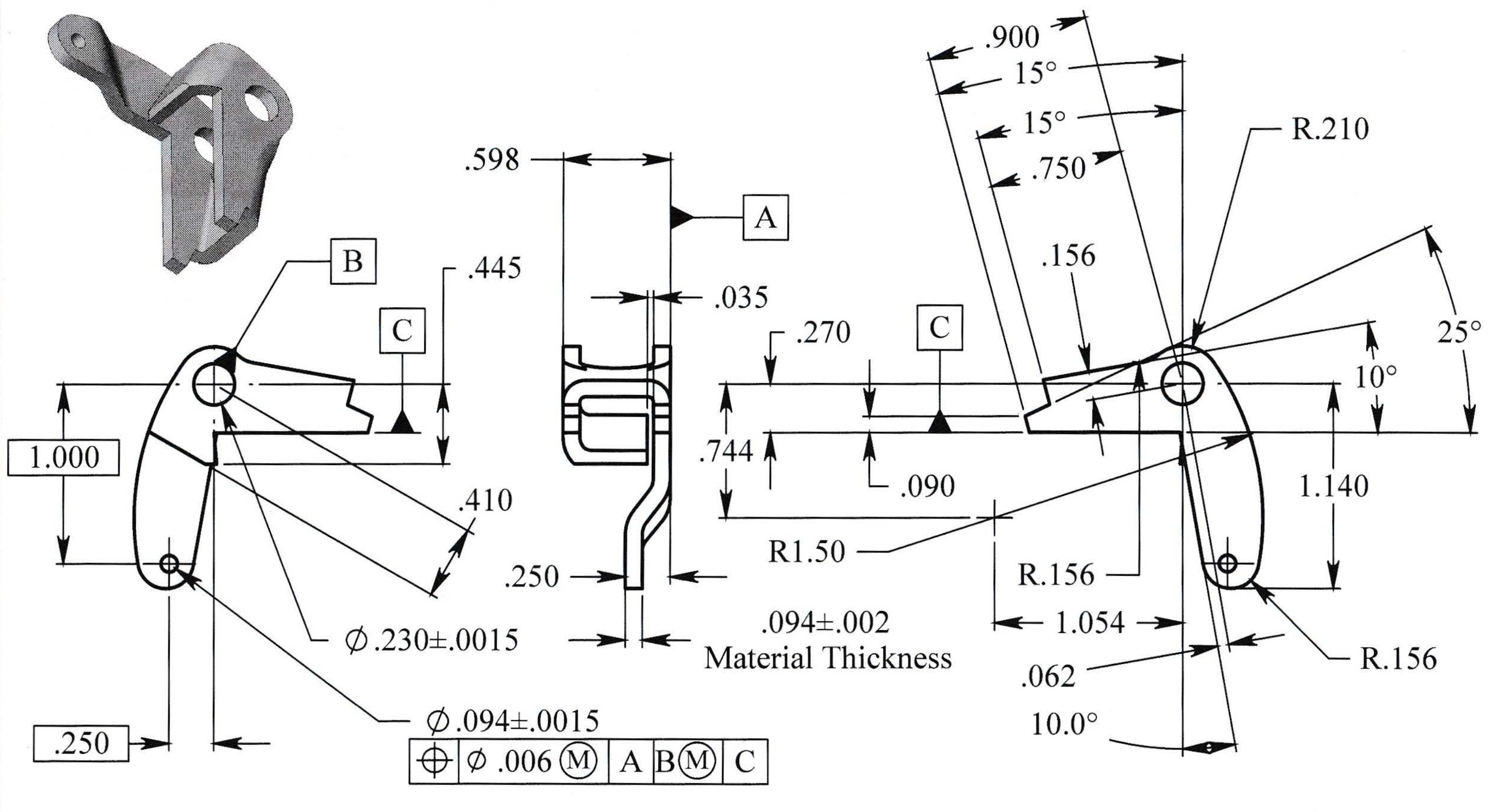


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1010 - 1020	STEN MK II
		HEAT TREAT None	PART NAME Return Spring Handle Clip
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 2:1

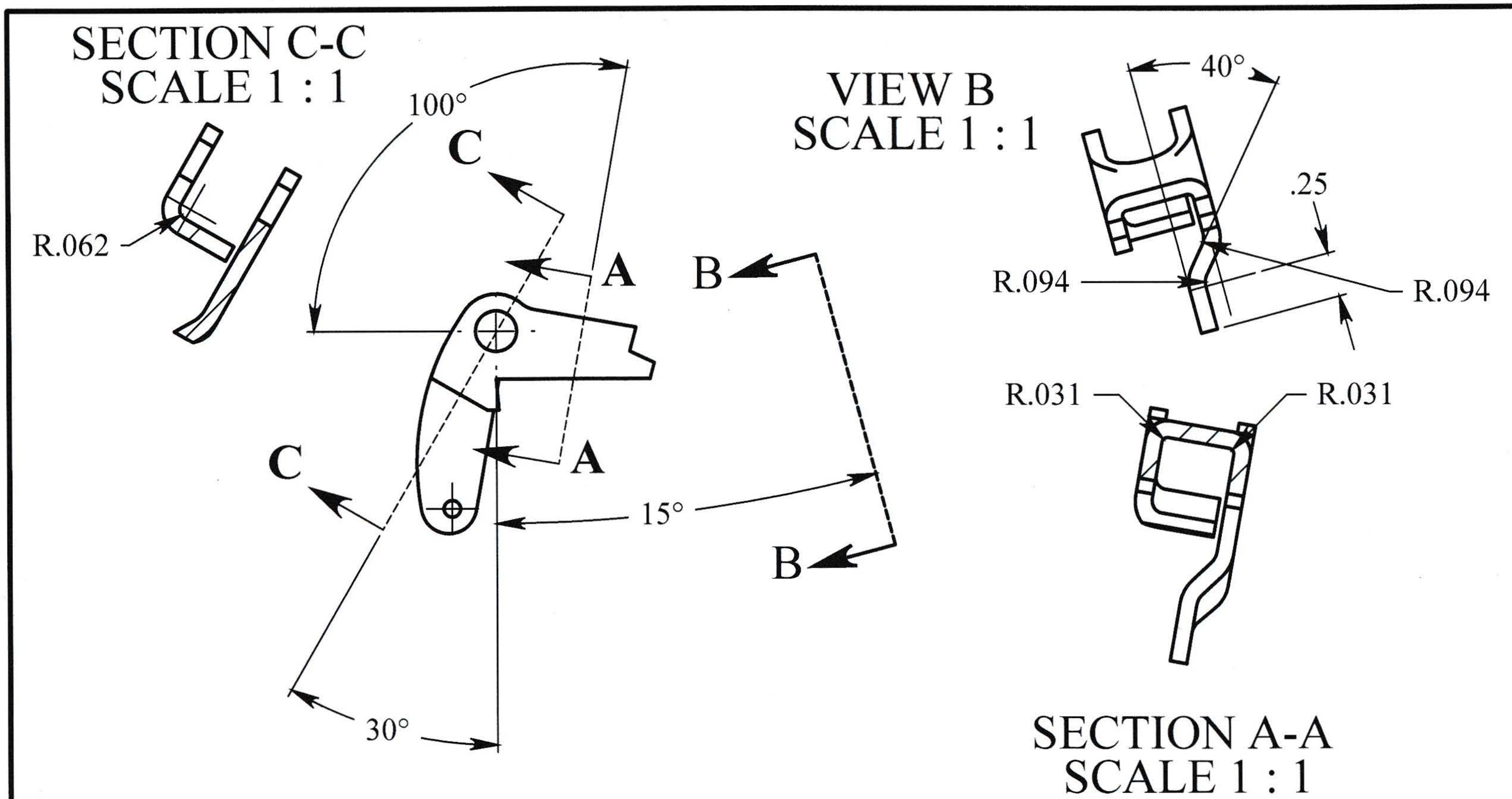


American National Standard
Slotted Round Head Cap Screw
ANSI B18.6.2 - 1972

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance →| |←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |←(C .XXX) Proprietary and Confidential	MATERIAL See Specification HEAT TREAT See Specification HARDNESS See Specification FINISH Black Oxide	STEN MK II PART NAME Screw (3 Required) OPERATION NAME OPERATION NO. / SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 4140	STEN MK II
		HEAT TREAT Quench &Temper	PART NAME Sear
		HARDNESS HRC 40 - 45	OPERATION NAME Outside Profile
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 10 — SCALE 1:1



Dimensions are in Inches

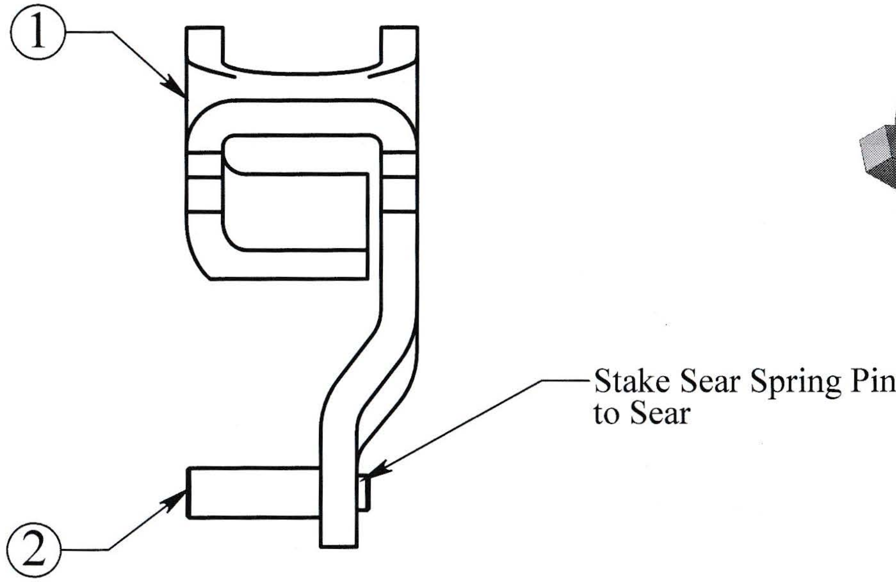
Tolerances:

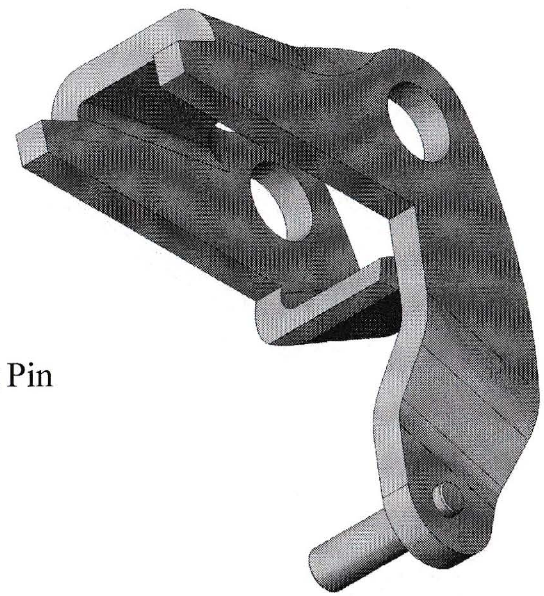
Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL: AISI 4140	STEN MK II
HEAT TREAT: Quench &Temper	PART NAME: Sear
HARDNESS: HRC 40 - 45	OPERATION NAME: Bends and Radii
FINISH: Black Oxide	OPERATION NO.: 20 — SCALE: 1:1





ITEM NO.	PART NUMBER	QTY.
1	Sear	1
2	Sear Spg Pin	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH Black Oxide

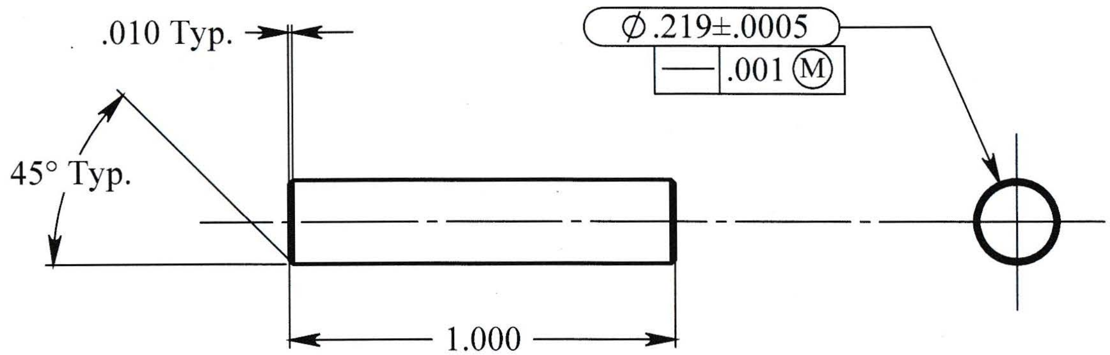
STEN MK II

PART NAME Sear Assembly

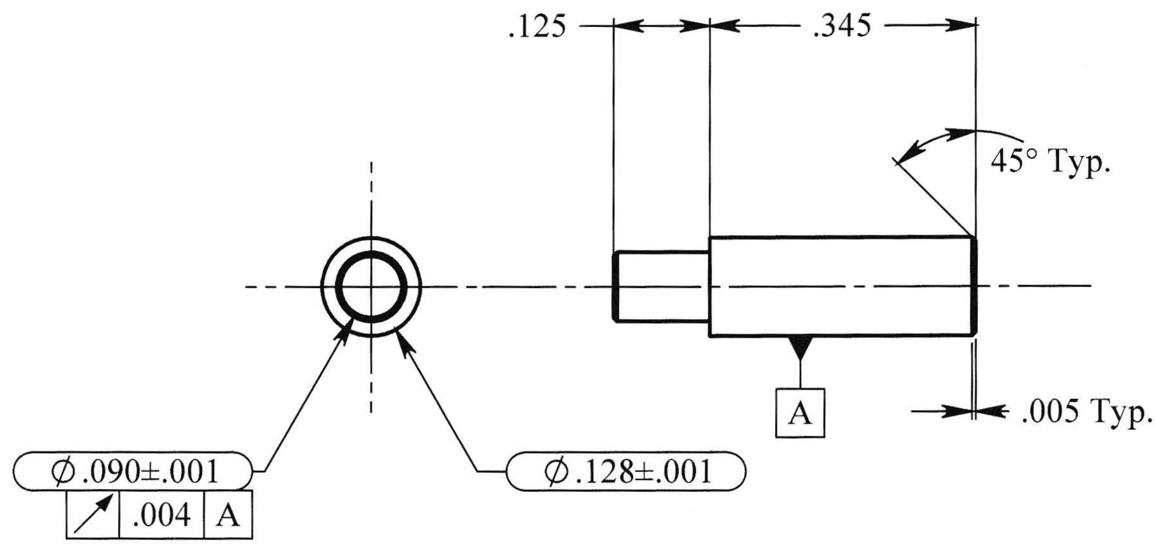
OPERATION NAME

OPERATION NO.

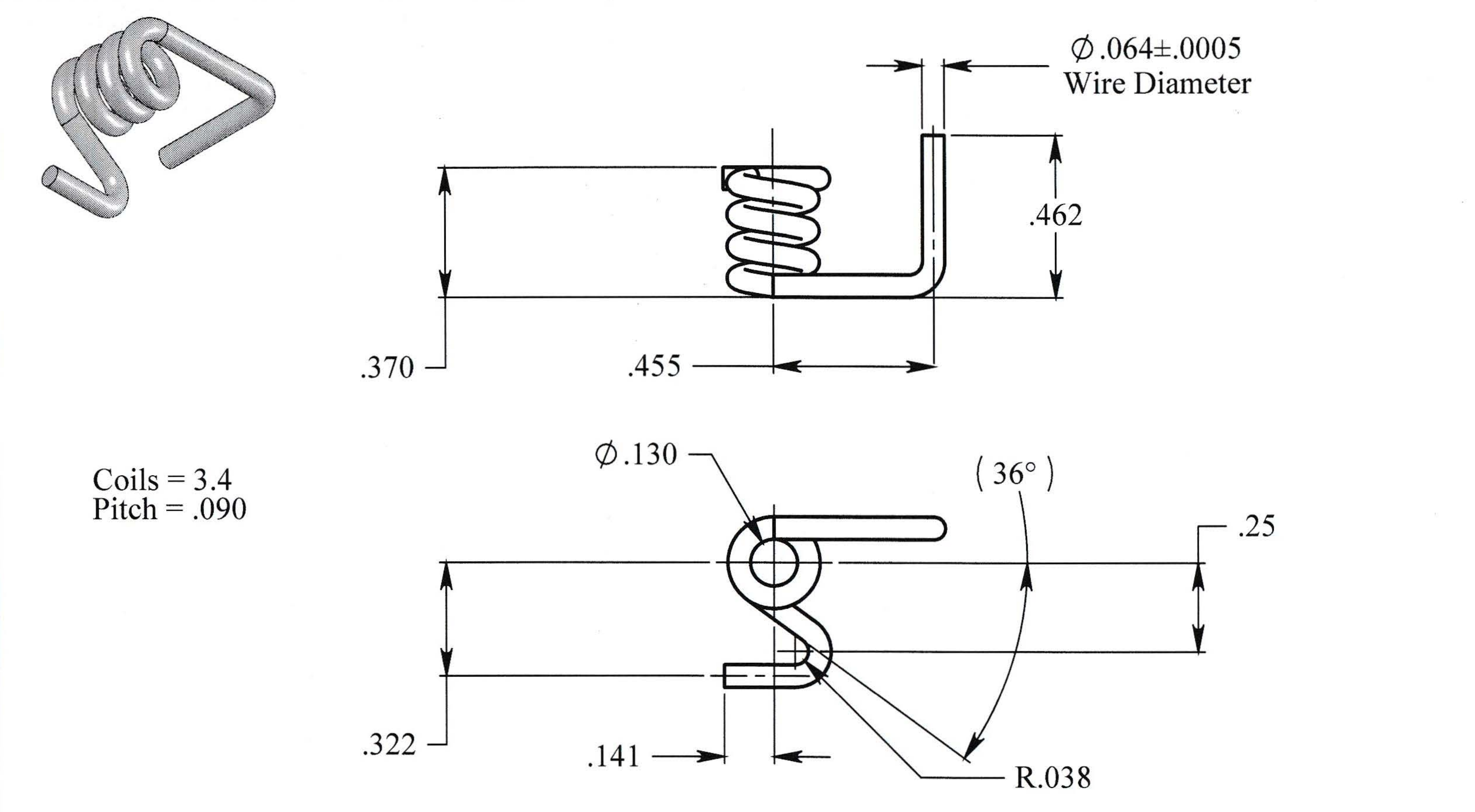
SCALE 2:1



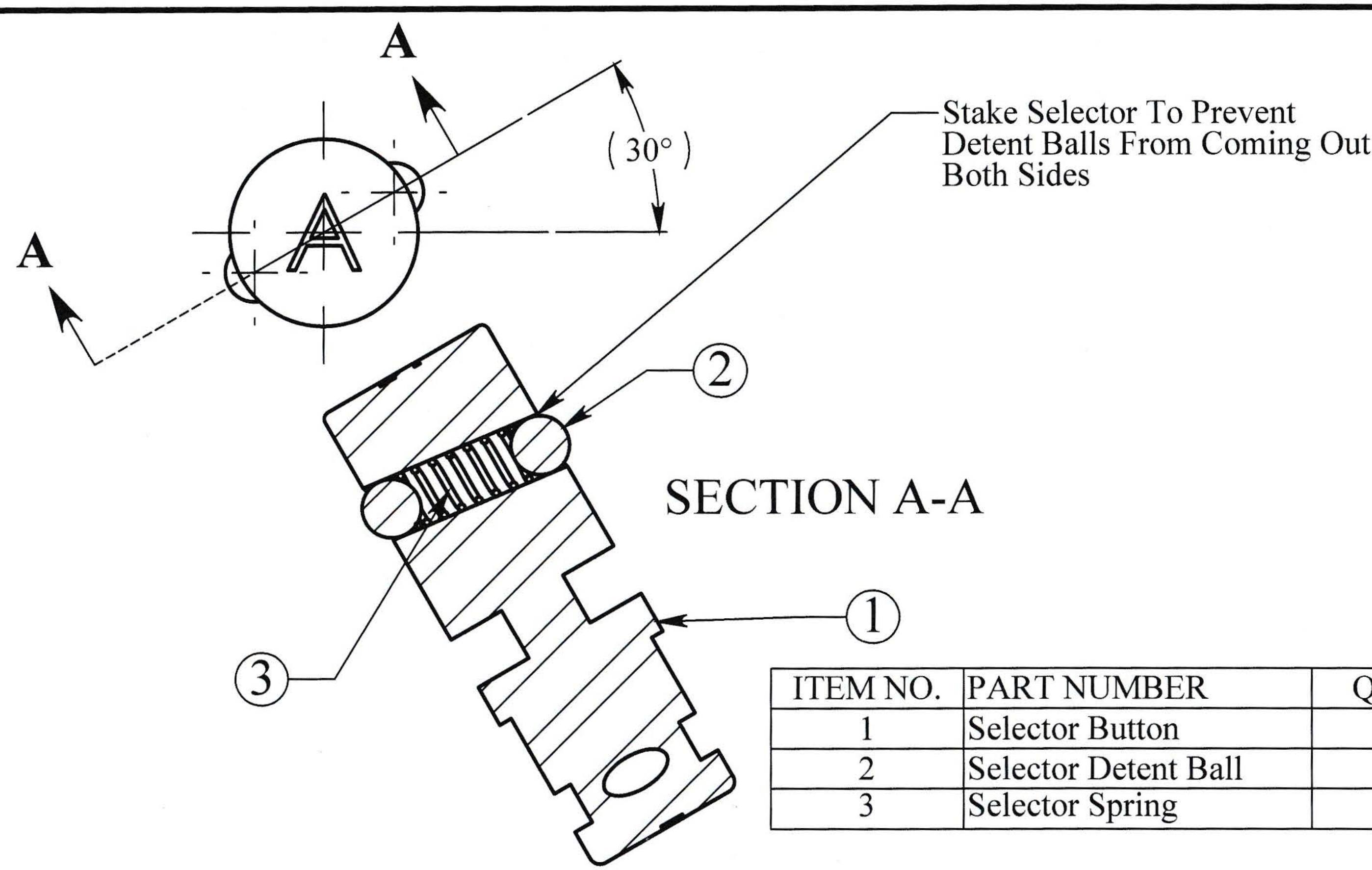
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1095	STEN MK II
		HEAT TREAT Neutral Salt Harden	PART NAME Sear Pivot Pin
		HARDNESS HRC 48 - 53	OPERATION NAME
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. / SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1095	STEN MK II	
		HEAT TREAT None	PART NAME Sear Spring Pin	
		HARDNESS HRB 100 Min.	OPERATION NAME	
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO.	SCALE 4:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL Music Wire (ASTM A228) HEAT TREAT HARDNESS FINISH Oiled	STEN MK II PART NAME Sear Spring OPERATION NAME OPERATION NO. — SCALE 2:1



ITEM NO.	PART NUMBER	QTY.
1	Selector Button	1
2	Selector Detent Ball	2
3	Selector Spring	1

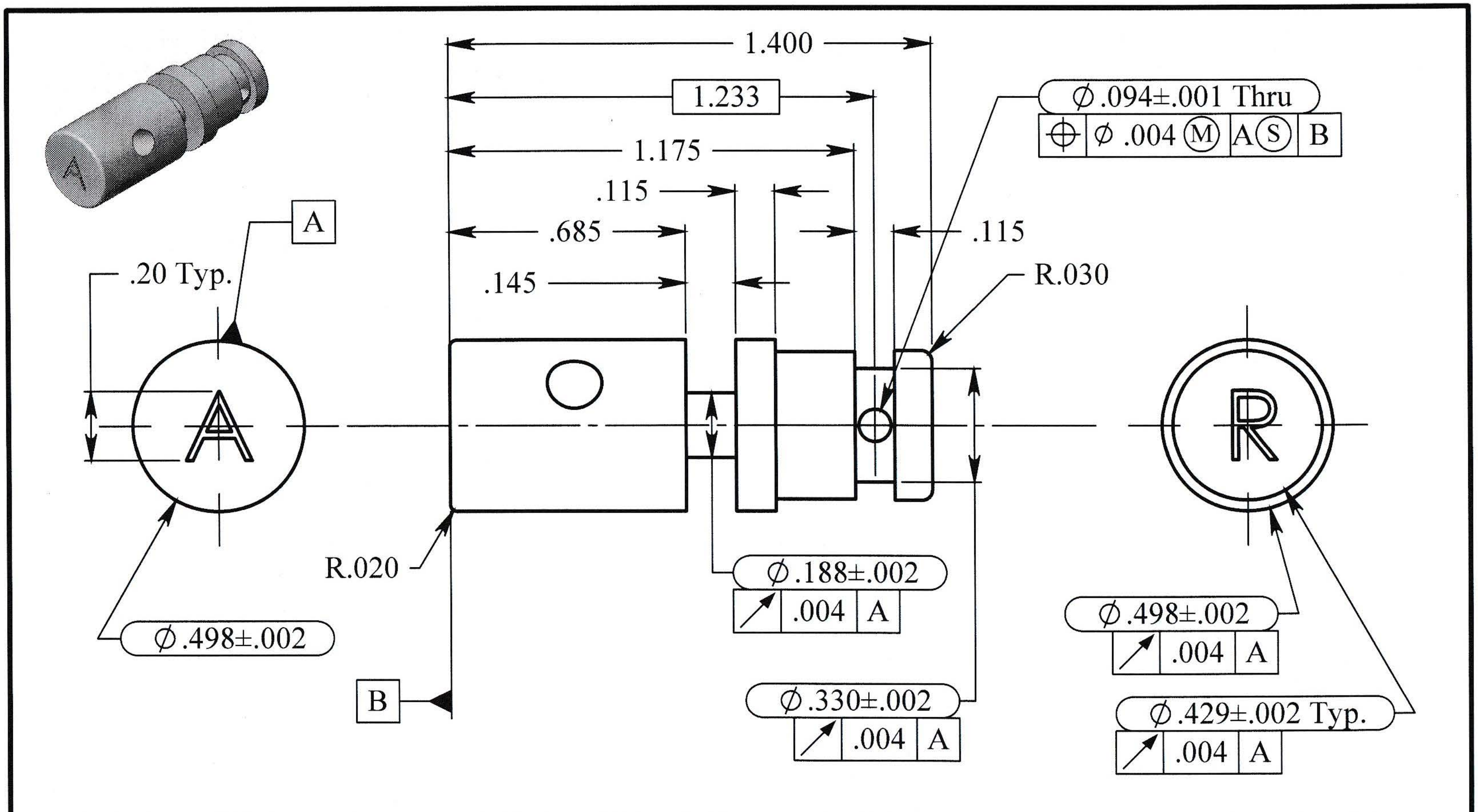
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

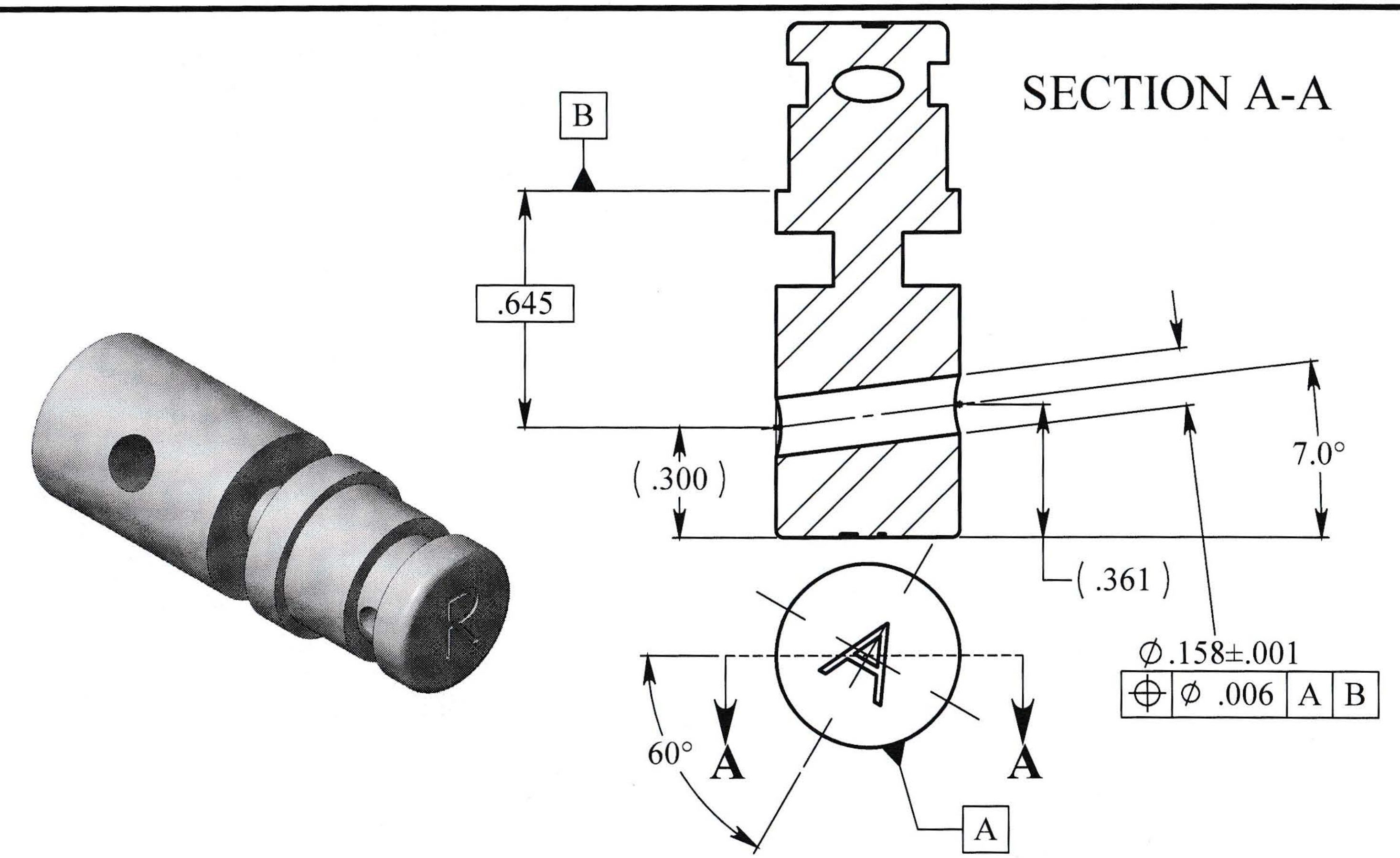
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

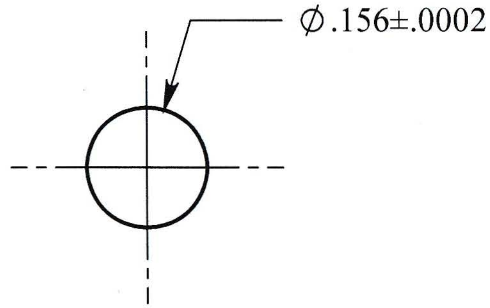
MATERIAL	STEN MK II
HEAT TREAT	PART NAME Selector Assembly
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance →| |← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |← C .XXX	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT None	PART NAME Selector Button
		HARDNESS HRB 100 Min.	OPERATION NAME 10
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. — SCALE 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 1118	STEN MK II	
		HEAT TREAT None	PART NAME Selector Button	
		HARDNESS HRB 100 Min.	OPERATION NAME Detent Hole	
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 20	SCALE 2:1



.156 Ball Bearing

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1085	STEN MK II
		HEAT TREAT Harden &Temper	PART NAME Selector Detent Ball
		HARDNESS HRC 58 - 63	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 4:1

Manufacturing Data:

Spring Type:	Helical Compression
Outside Diameter:	.141 inches
Wire Diameter:	.018
Total Coils:	8.0
Active Coils:	6.0
Coil Type:	Closed, and Ground
Free Length:	.50
Wind Direction:	Either Hand

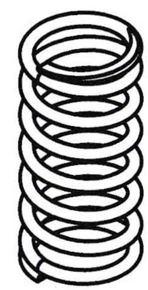
Inspection Data:

Load Length L1:	.300 inches
Load P1:	2.70 +/-.20 lbs.
Load Length L2:	.270 inches
Load P2:	3.10 +/-.20 lbs.
Max. Solid Height:	.150 inches

Engineering Data:

Spring Rate:	13.5 lbs/in.
Spring Index:	6.8
Static Solid Stress:	314,900 psi
Stress Percentage: at Solid Height	88.1%

Do Not Set to Solid Height For Inspection



Dimensions are in Inches

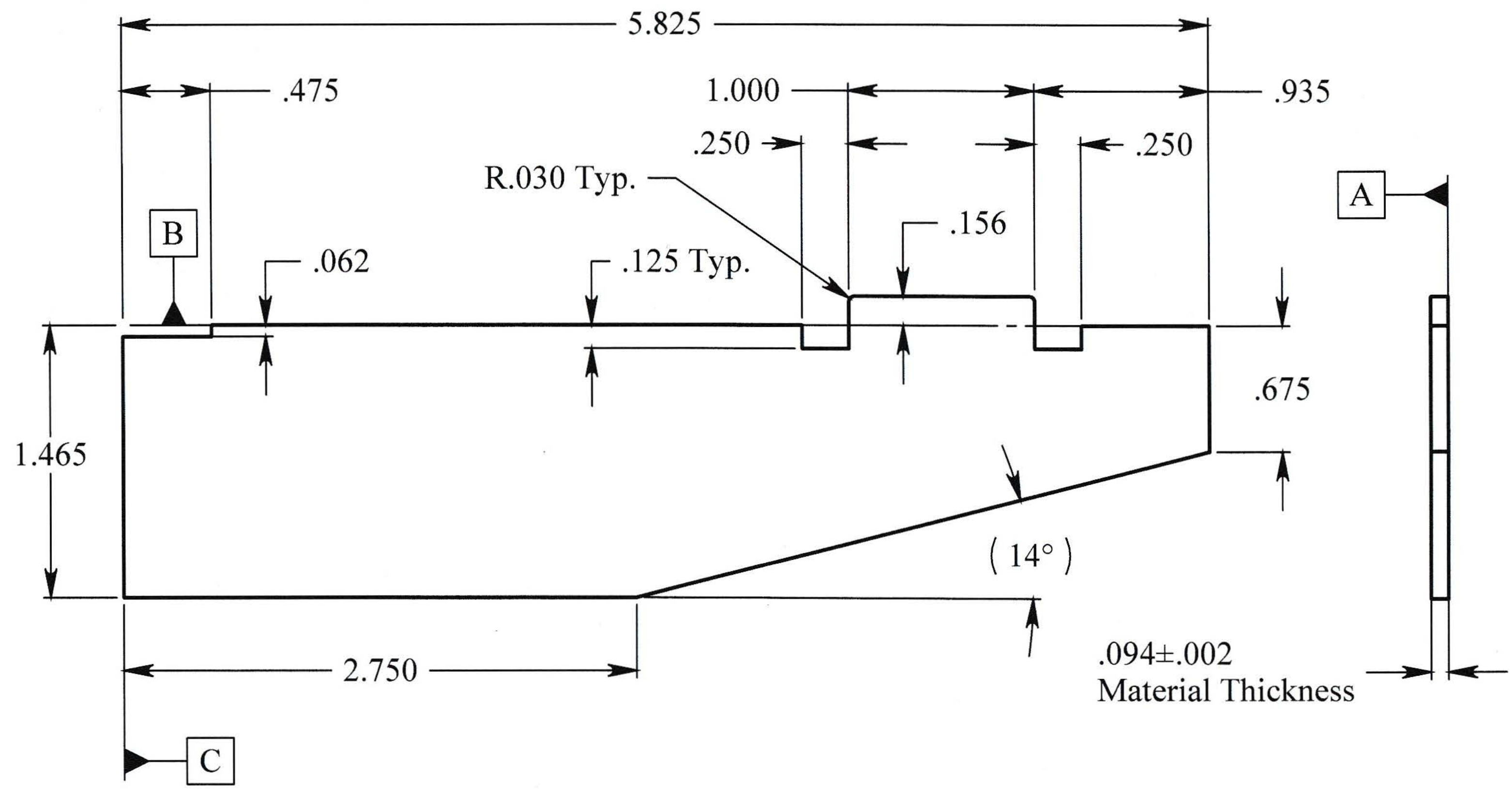
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL: Music Wire (ASTM A228)	STEN MK II
HEAT TREAT: Stress Relieve	PART NAME: Selector Spring
HARDNESS:	OPERATION NAME:
FINISH: Oiled	OPERATION NO.: SCALE: 4:1



Dimensions are in Inches

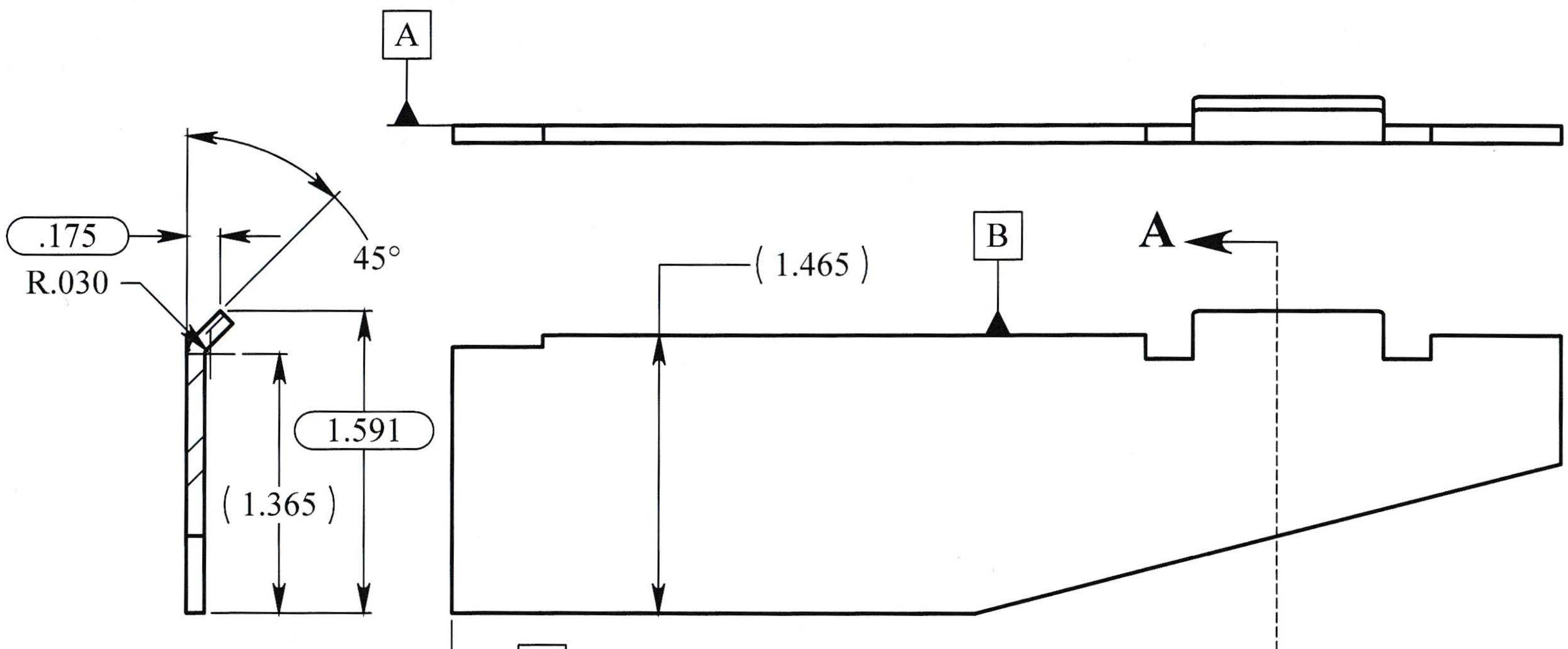
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II
HEAT TREAT	PART NAME Side Plate Flat Pattern Blank
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:1



SECTION A-A
SCALE 1 : 1

Part Formed from Side Plate Blank

Dimensions are in Inches

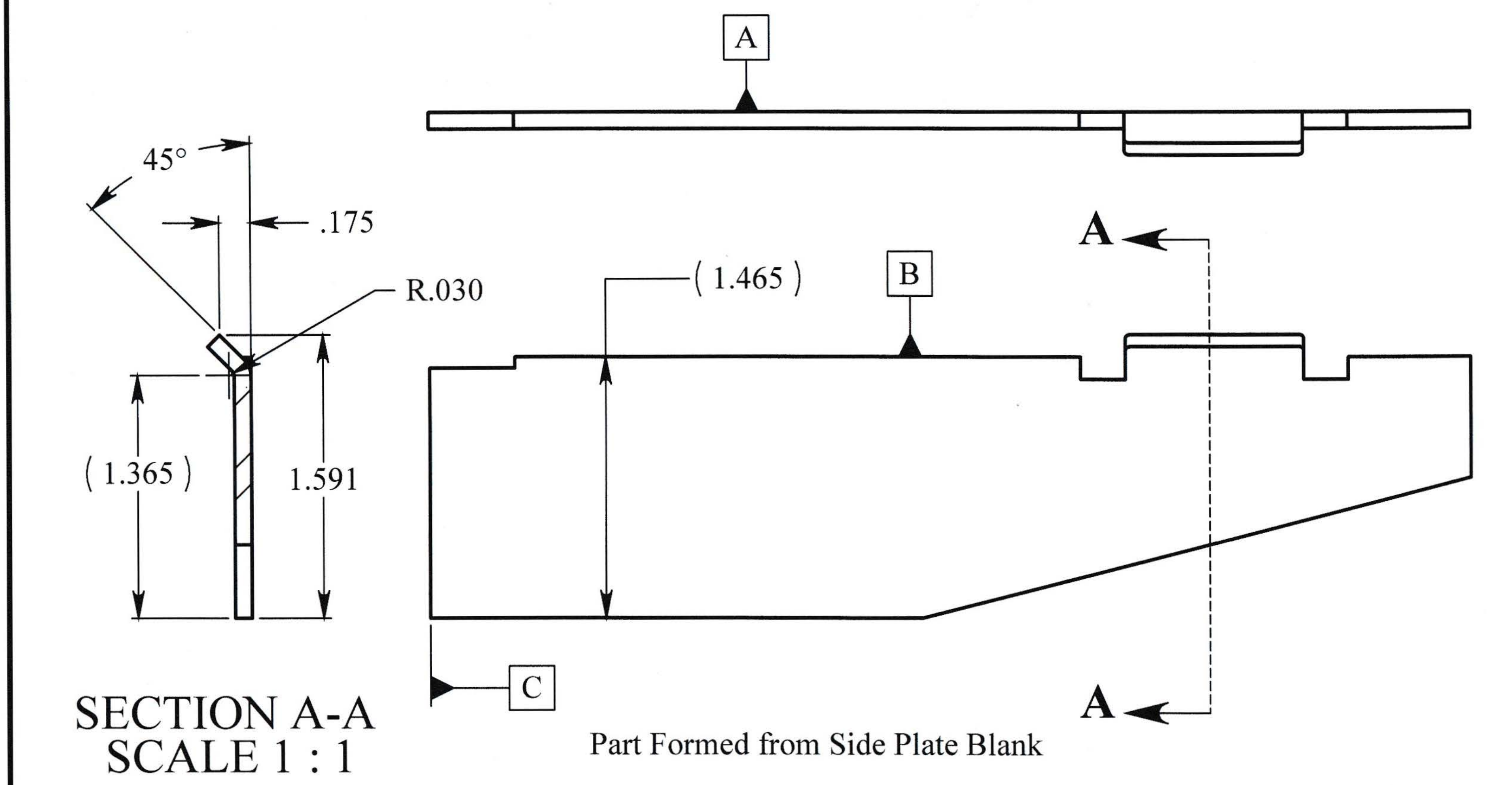
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL: AISI 1010 Ref.
HEAT TREAT:
HARDNESS:
FINISH:

STEN MK II
PART NAME: Side Plate - LH
OPERATION NAME: Formed
OPERATION NO.:
SCALE: 1:1



Dimensions are in Inches

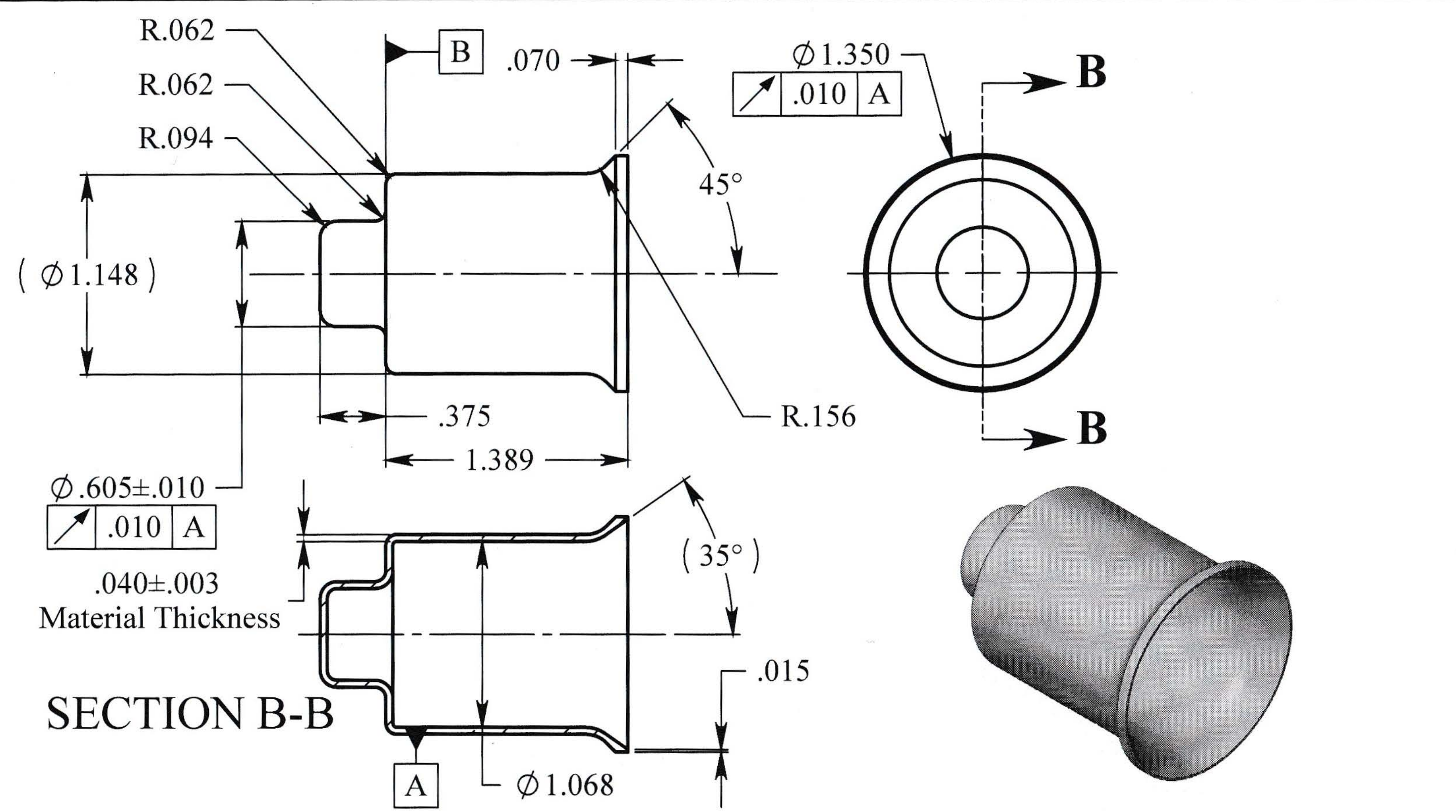
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1010 Ref.	STEN MK II
HEAT TREAT	PART NAME Side Plate - RH
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:1



Dimensions are in Inches

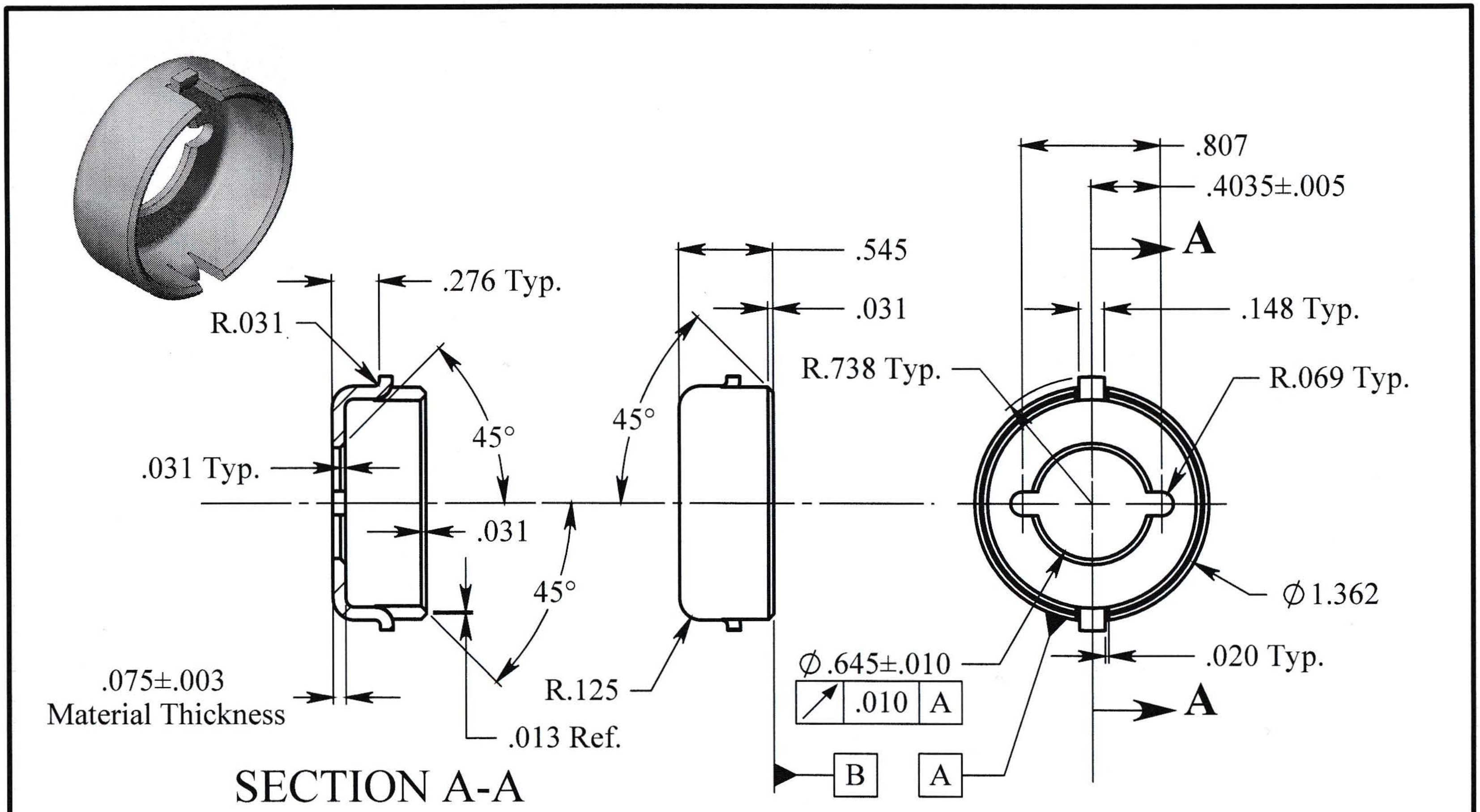
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Spring Cap
HARDNESS HRB 100 Min.	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 1:1



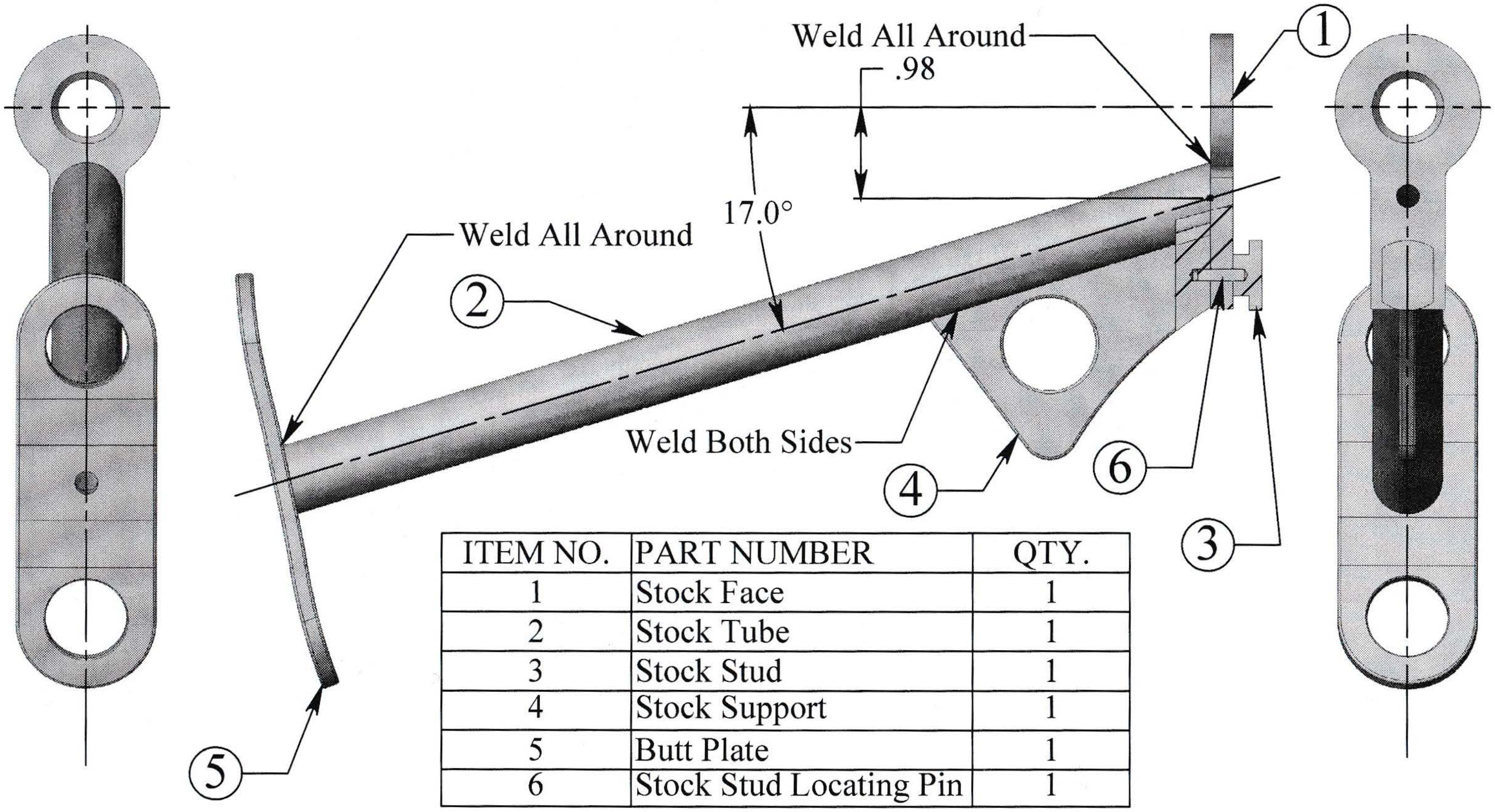
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Spring Retainer
HARDNESS HRB 100 Min.	OPERATION NAME
FINISH None	OPERATION NO. — SCALE 1:1



ITEM NO.	PART NUMBER	QTY.
1	Stock Face	1
2	Stock Tube	1
3	Stock Stud	1
4	Stock Support	1
5	Butt Plate	1
6	Stock Stud Locating Pin	1

Dimensions are in Inches

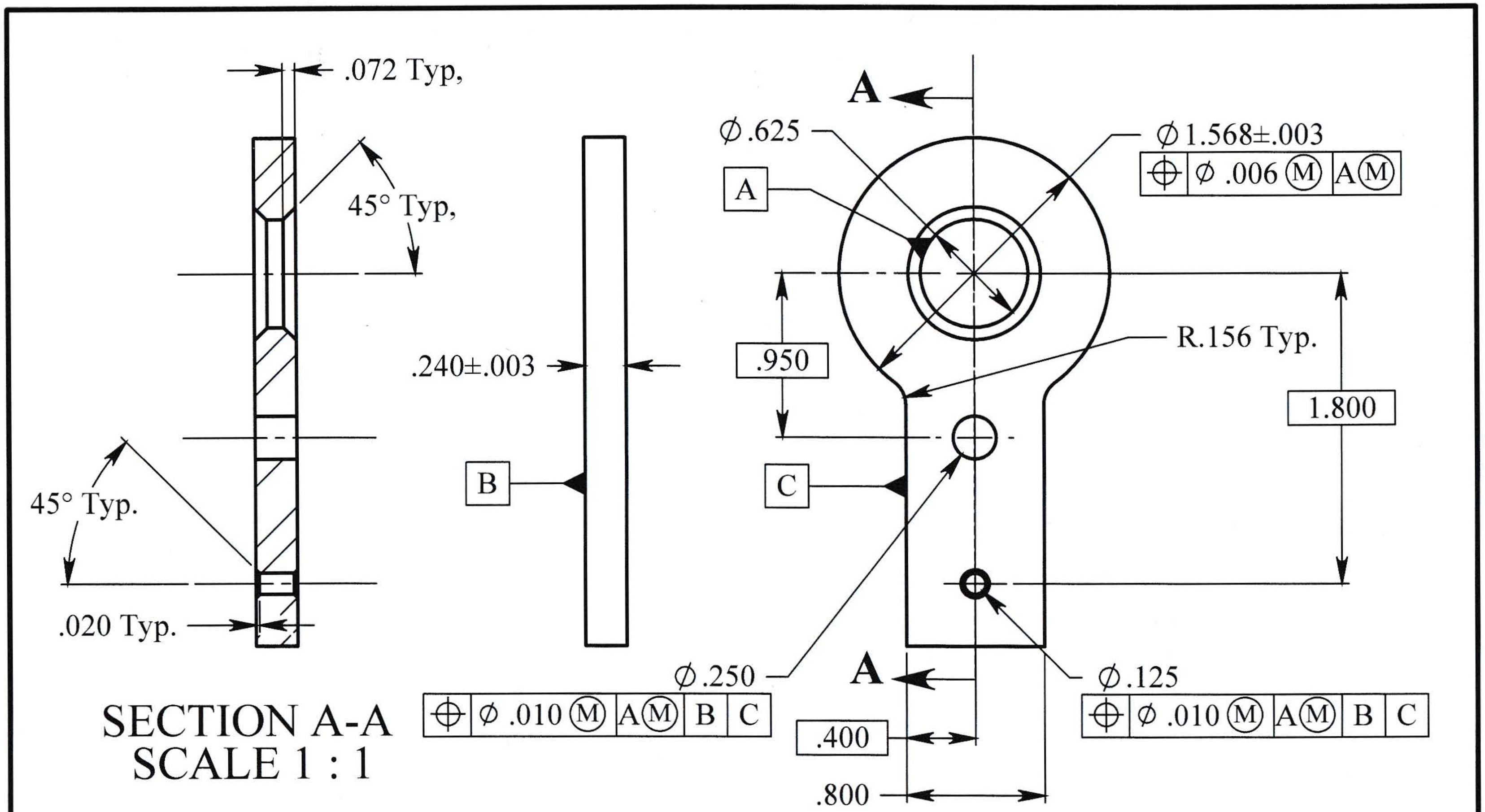
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX

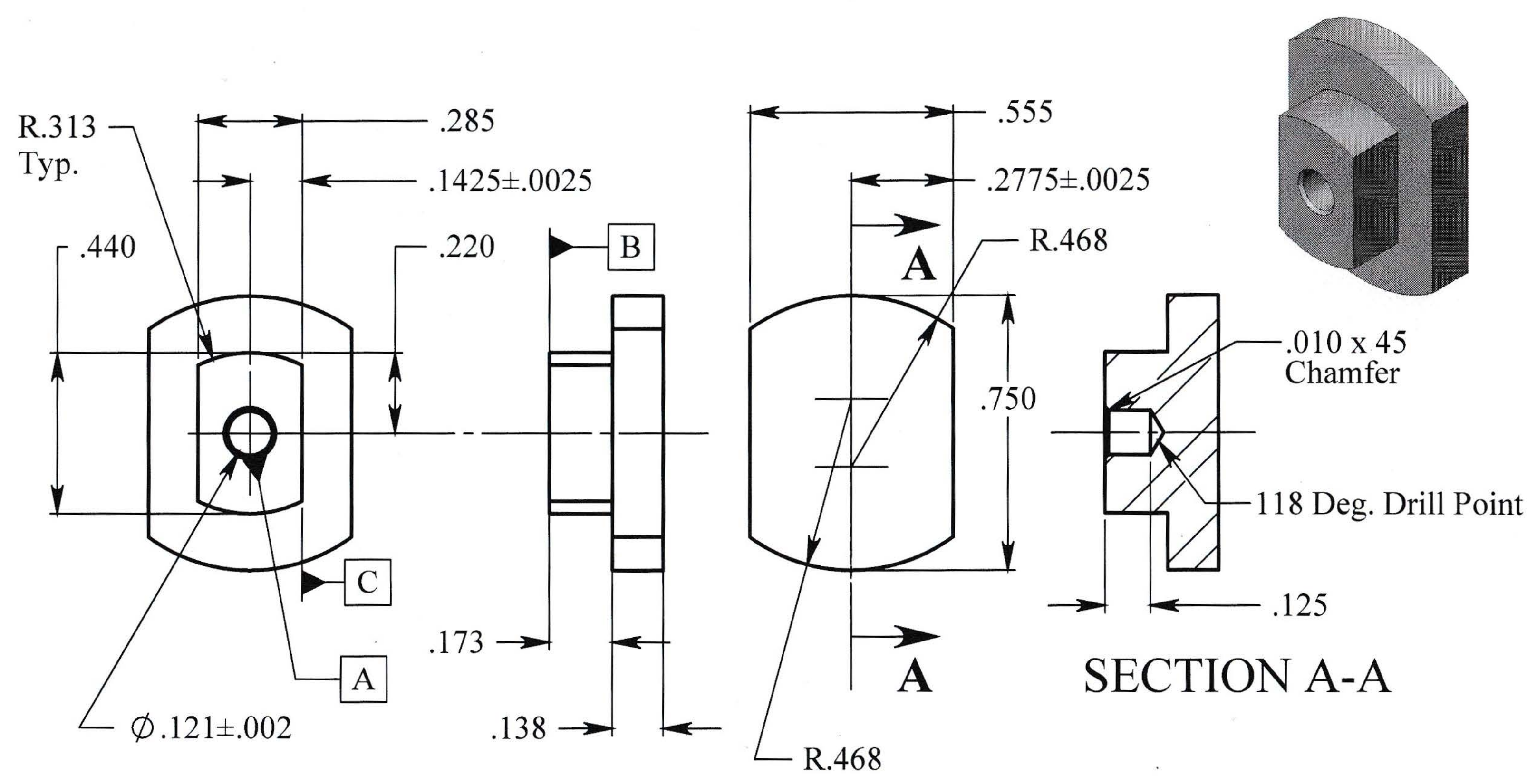
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL	STEN MK II
HEAT TREAT	PART NAME Stock Assembly
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT None	PART NAME Stock Face
		HARDNESS HRB 100 Min.	OPERATION NAME
		FINISH None	OPERATION NO. / SCALE 1:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL
AISI 1118

HEAT TREAT
None

HARDNESS
HRB 100 Min.

FINISH
None

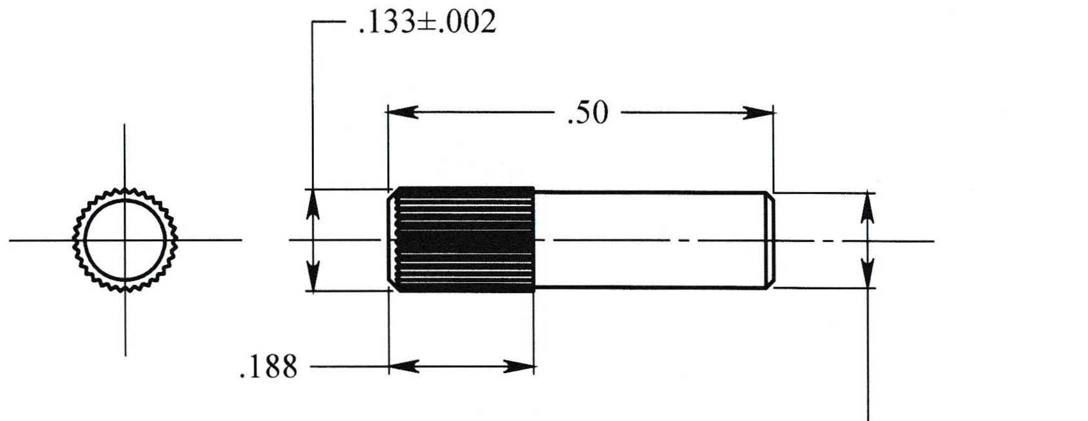
STEN MK II

PART NAME
Stock Stud

OPERATION NAME

OPERATION NO.

SCALE
2:1



Drive-Loc Knurled Pin

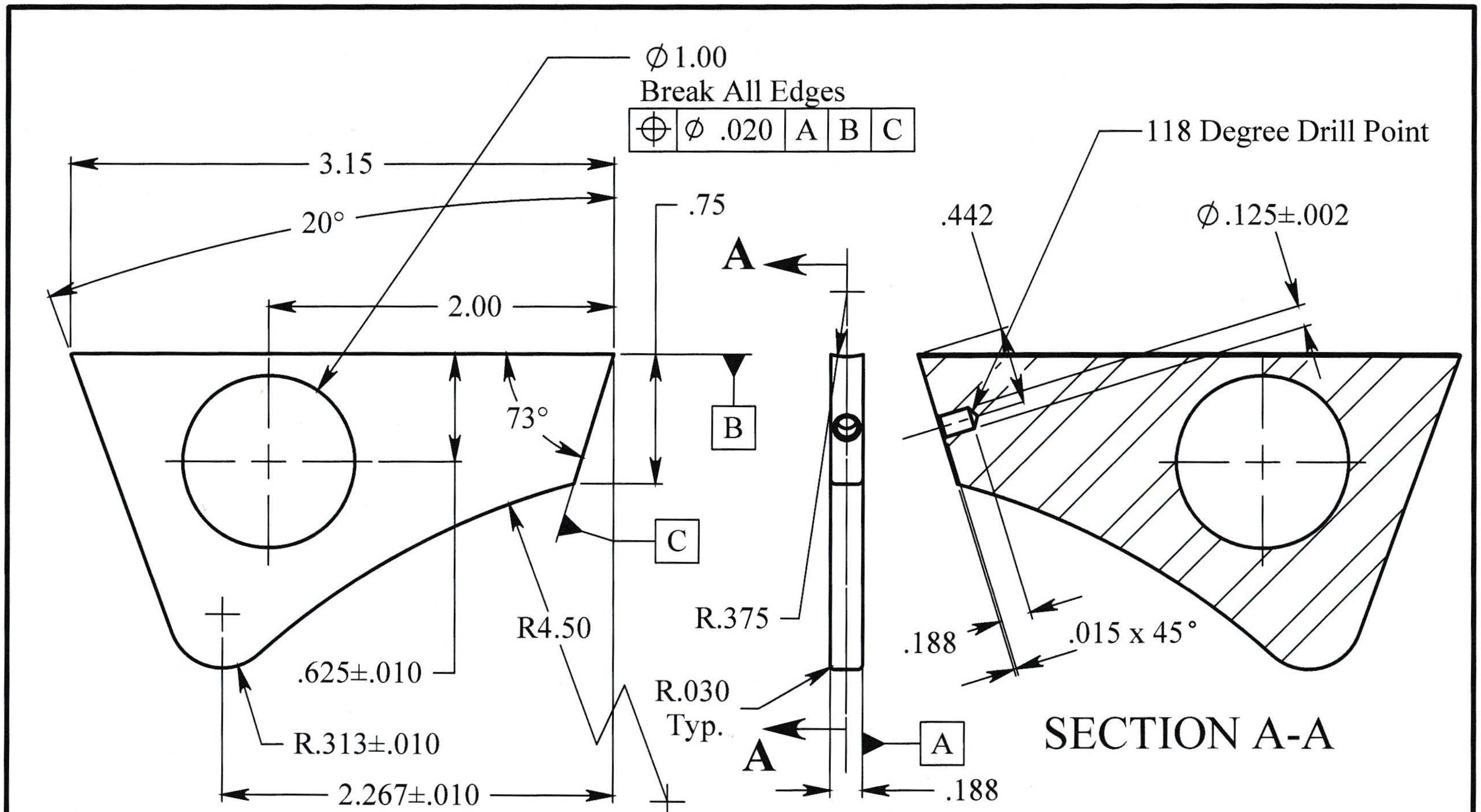
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

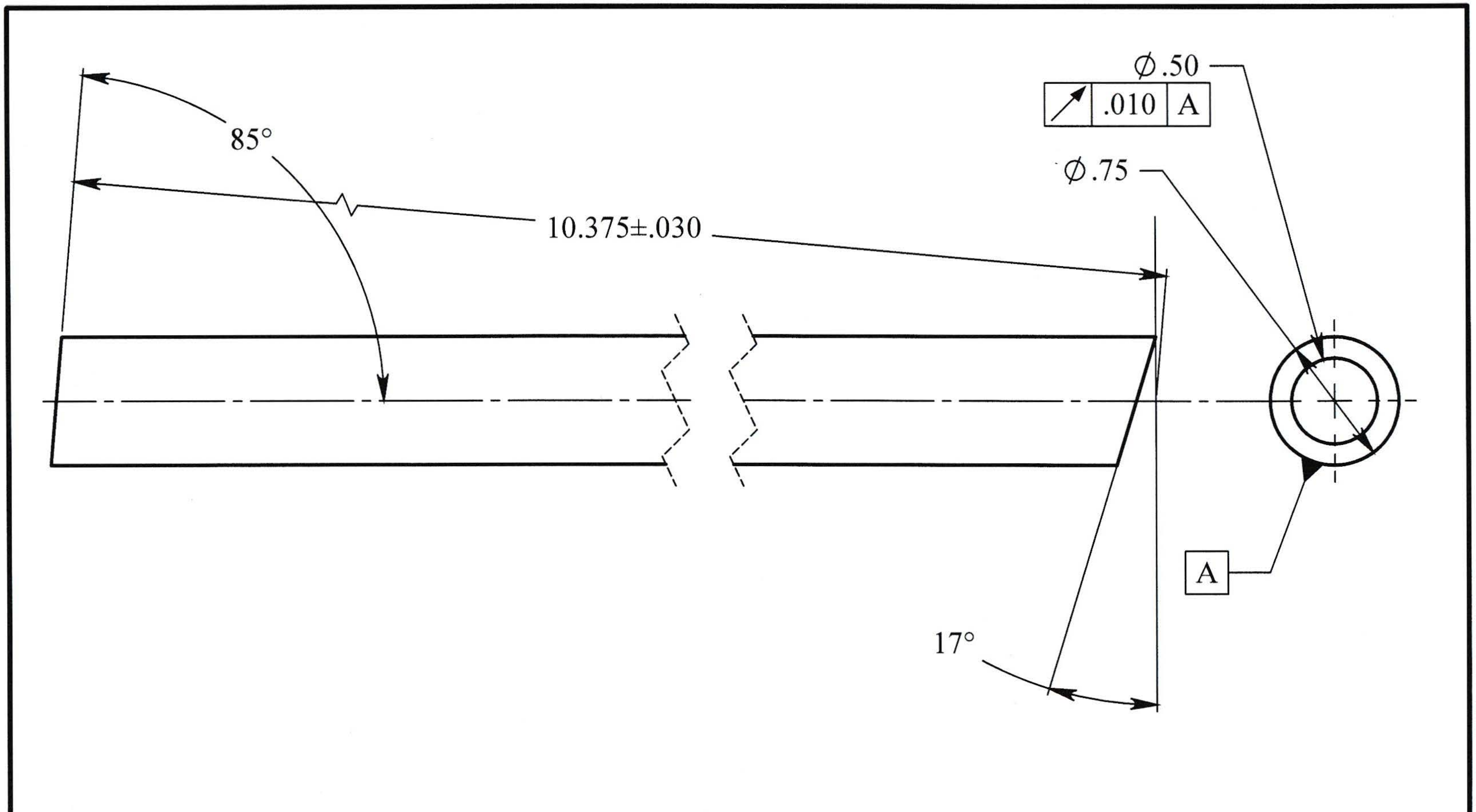
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL Alloy Carbon Steel	STEN MK II
HEAT TREAT Vendor Spec.	PART NAME Stock Stud Locating Pin
HARDNESS Vendor Spec.	OPERATION NAME
FINISH Black Oxide	OPERATION NO. / SCALE 4:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX)	MATERIAL AISI 1118	STEN MK II
		HEAT TREAT None	PART NAME Stock Support
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 1:1



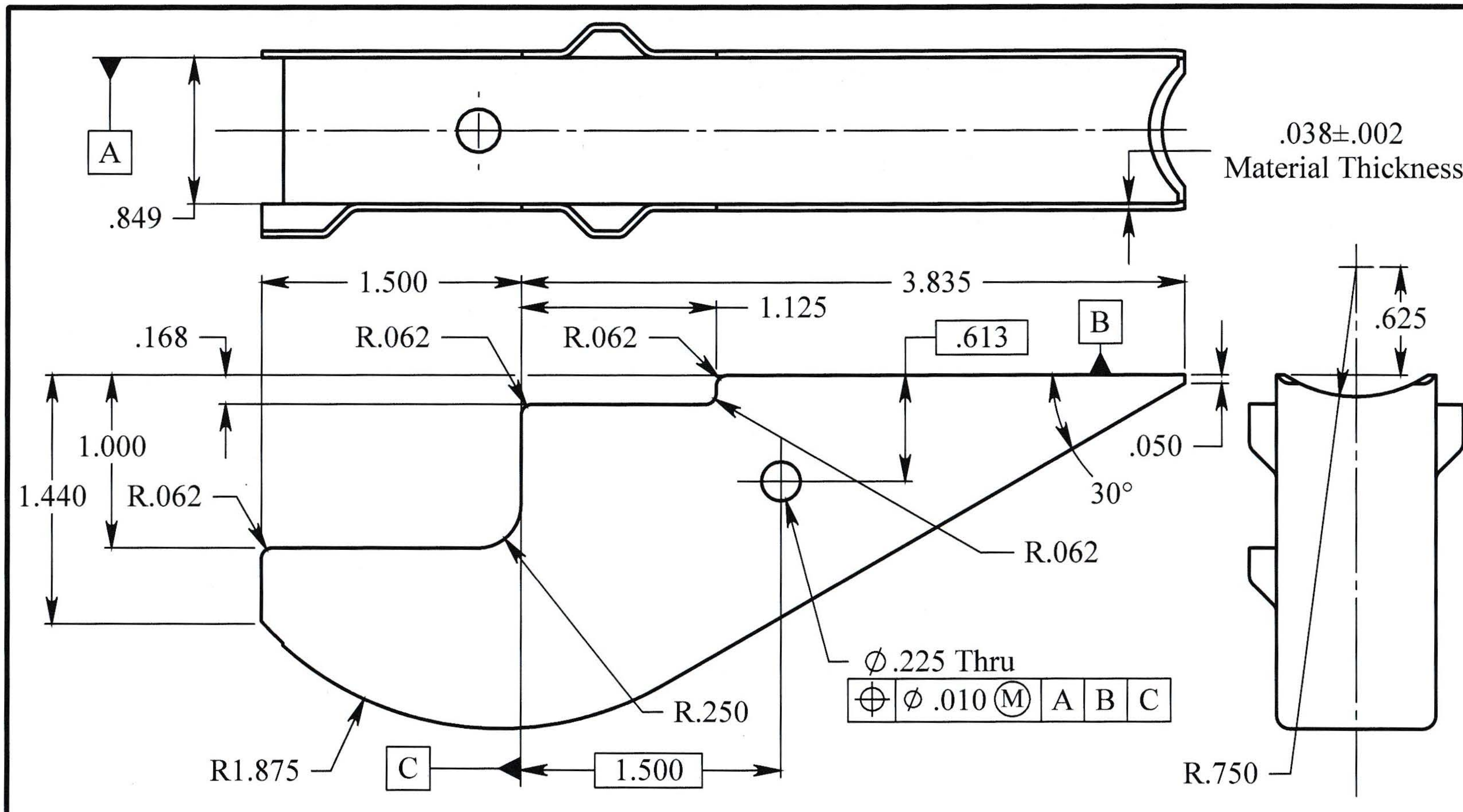
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

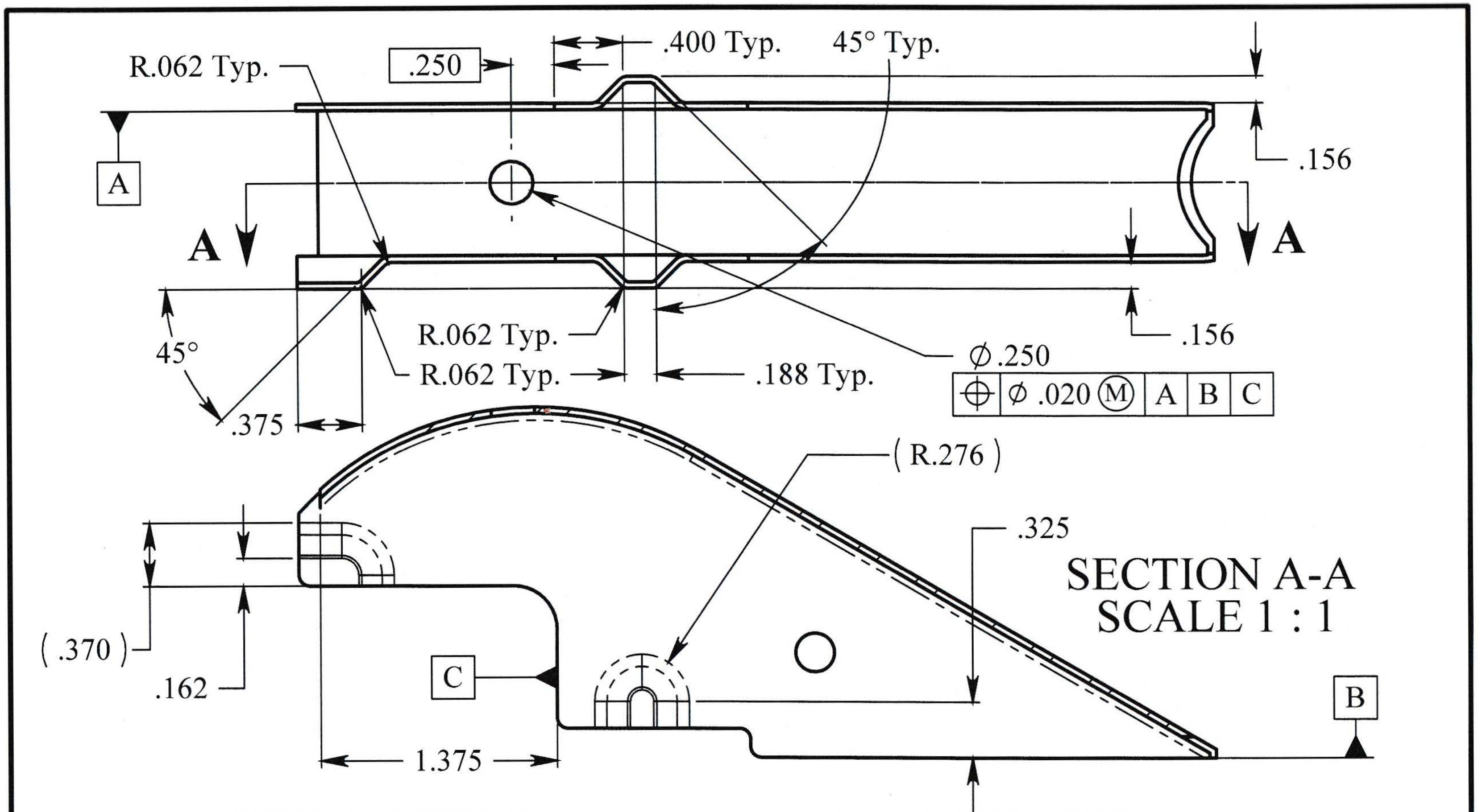
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX ←
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX ←

Proprietary and Confidential

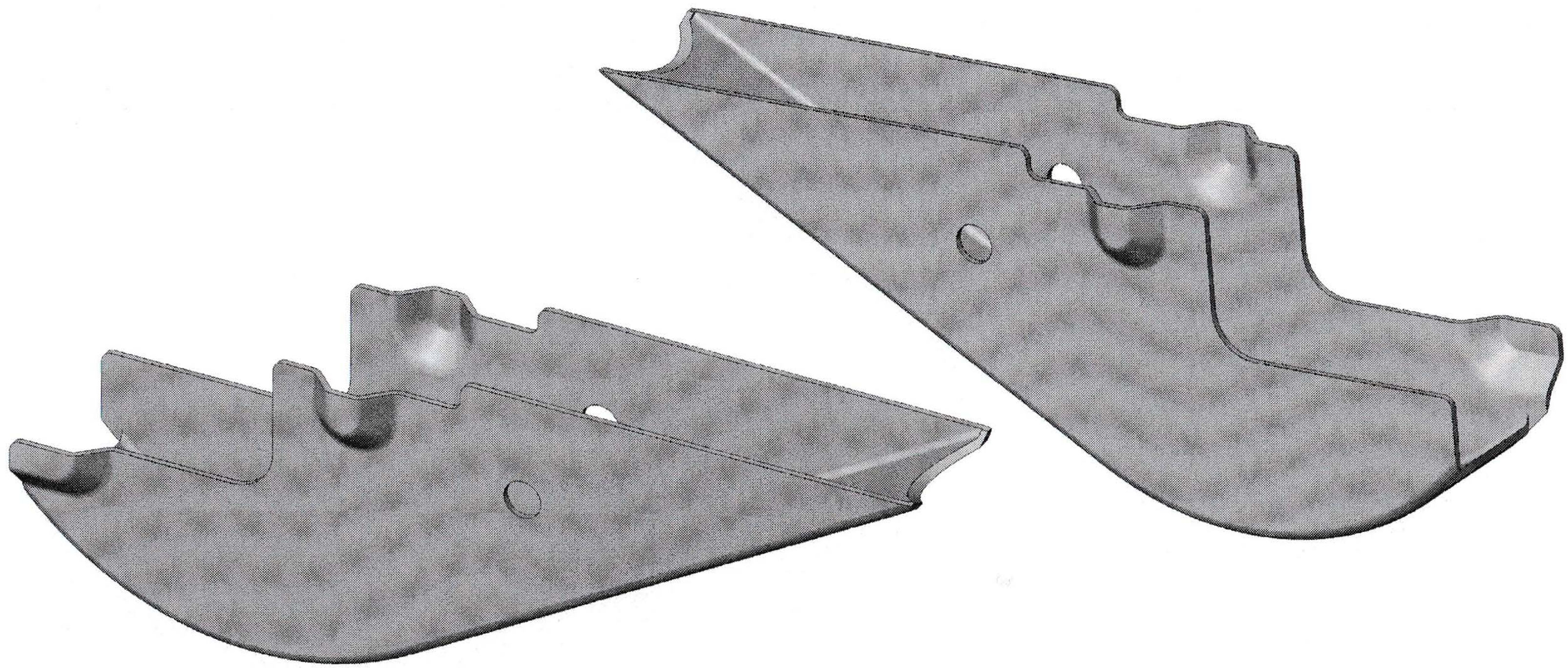
MATERIAL AISI 1118	STEN MK II
HEAT TREAT None	PART NAME Stock Tube
HARDNESS HRB 100 Min.	OPERATION NAME
FINISH None	OPERATION NO. / SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance (.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% (C .XXX) Proprietary and Confidential	MATERIAL AISI 1010	STEN MK II
		HEAT TREAT	PART NAME Trigger Housing Cover
		HARDNESS	OPERATION NAME Profile
		FINISH Black Oxide	OPERATION NO. 10 — SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance →| |←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% →| |←(C .XXX) Proprietary and Confidential	MATERIAL AISI 1010 HEAT TREAT HARDNESS FINISH Black Oxide	STEN MK II PART NAME Trigger Housing Cover OPERATION NAME Forming OPERATION NO. 20 SCALE 1:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1010	STEN MK II
HEAT TREAT	PART NAME Trigger Housing Cover
HARDNESS	OPERATION NAME Finish
FINISH Black Oxide	OPERATION NO. 30 / SCALE 1:1

Manufacturing Data:

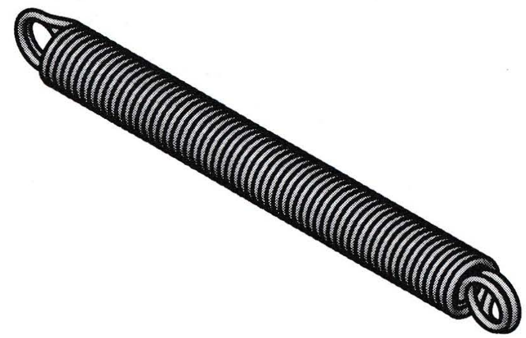
Spring Type:	Extension Spring
Outside Diameter:	.178 inches
Wire Diameter:	.024
Total Coils:	60.0
Active Coils:	60.0
End Coil Type:	Double Full Loop
Free Length:	1.83
Wind Direction:	Either Hand

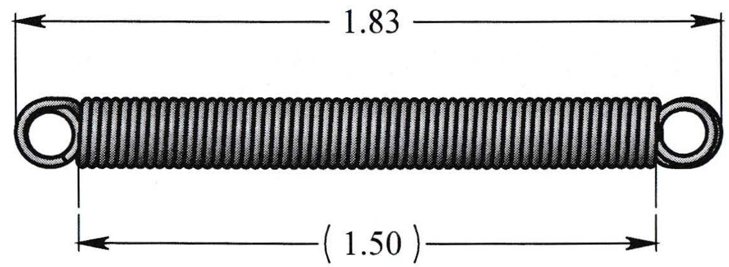
Inspection Data:

Load Length L1:	2.75 inches
Load P1:	2.5 +/-.25 lbs.
Load Length L2:	3.0 inches
Load P2:	3.0 lbs +/-.27 lbs.

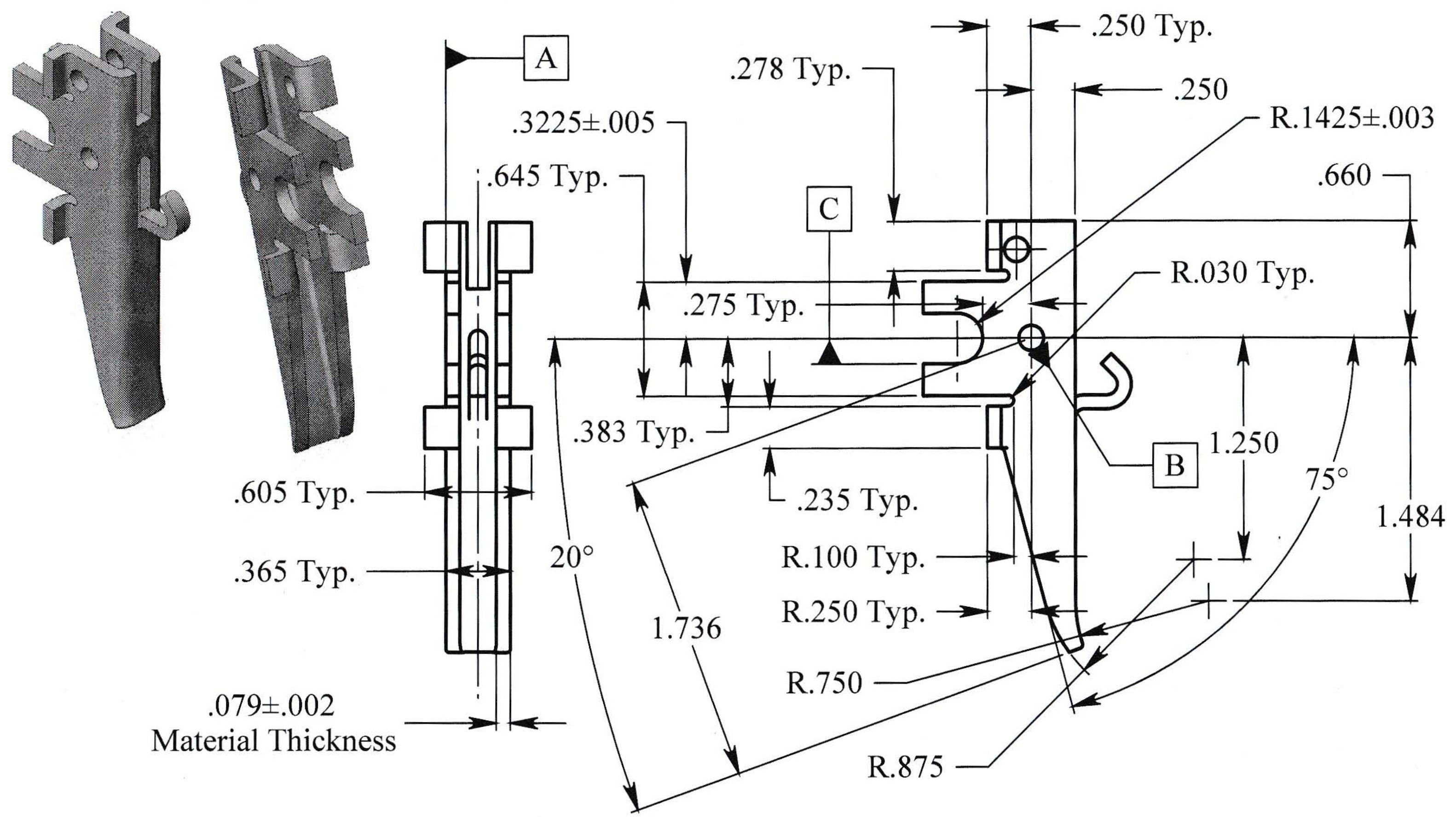
Engineering Data:

Spring Rate:	2.05 lbs/in.
Spring Index:	6.5
Hook Stress:	201,500 psi
Hook Stress %:	58.8%





Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL Music Wire (ASTM A228)	STEN MK II
		HEAT TREAT Stress Relieve	PART NAME Trigger Spring
		HARDNESS	OPERATION NAME
	Proprietary and Confidential	FINISH Oiled	OPERATION NO. / SCALE 2:1



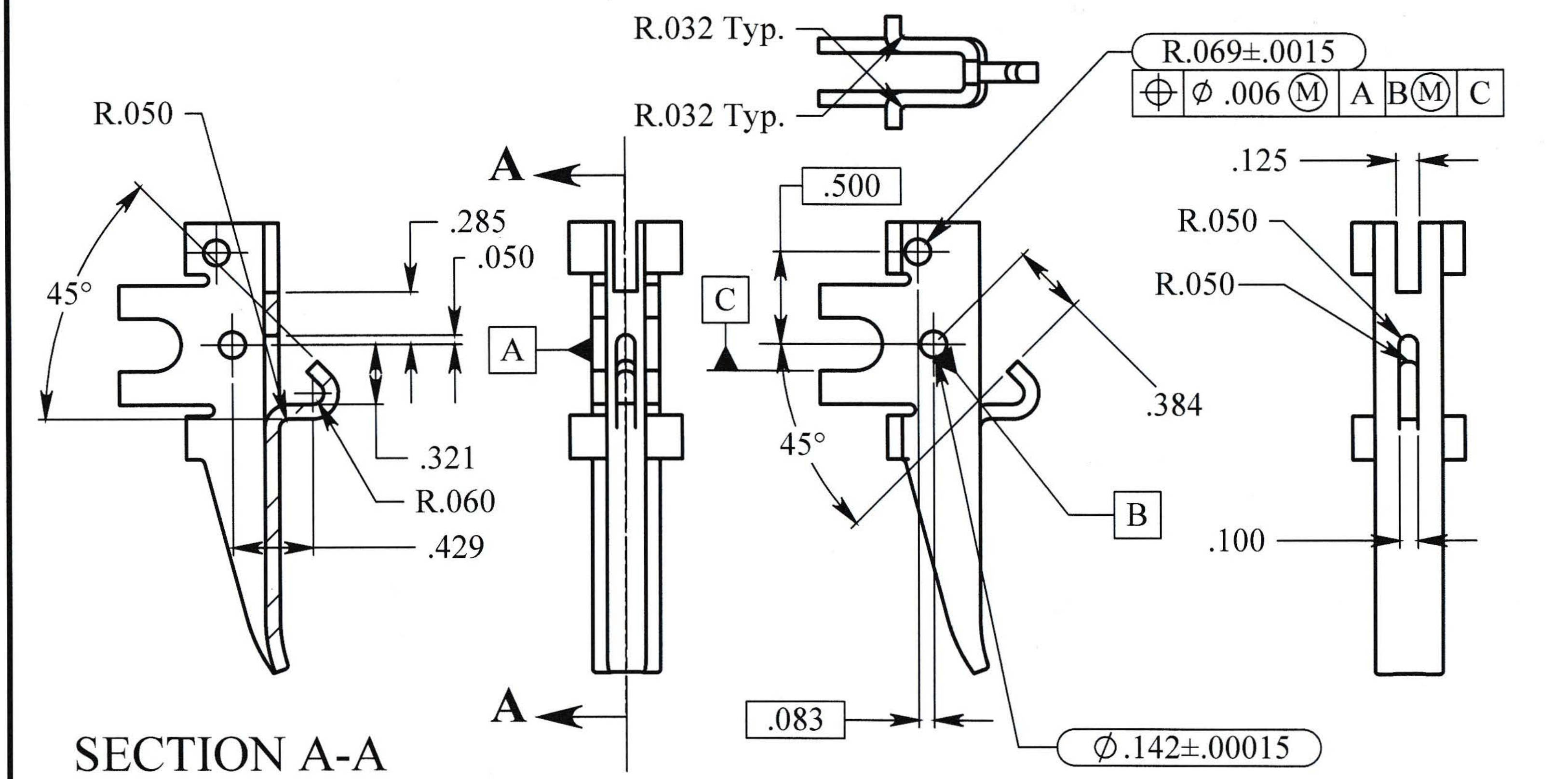
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

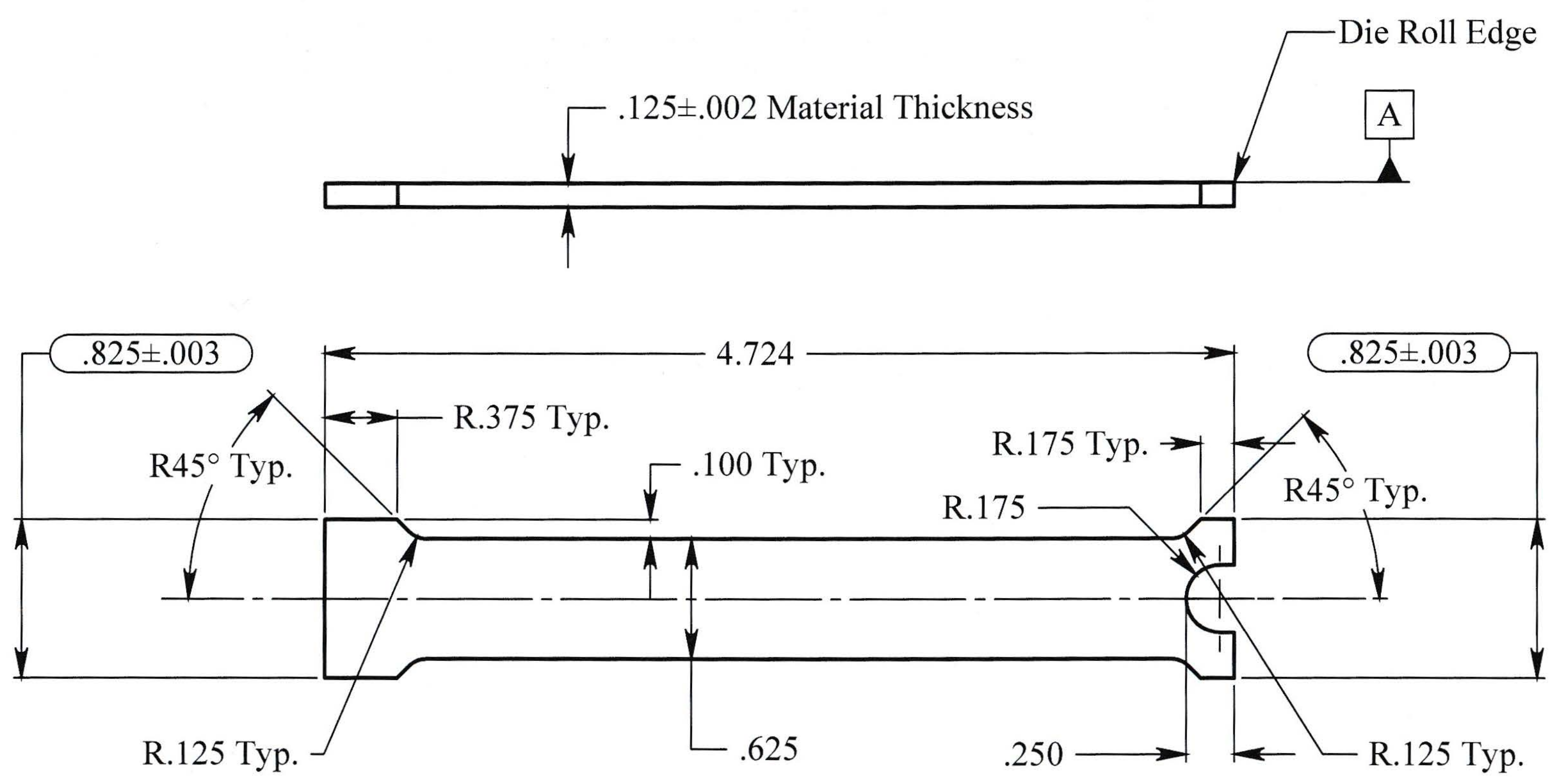
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118	STEN MK II
HEAT TREAT Carburize .7 C	PART NAME Trigger
HARDNESS HR15N 88 - 92	OPERATION NAME Outside Profile
FINISH Black Oxide	OPERATION NO. 10 / SCALE 1:1

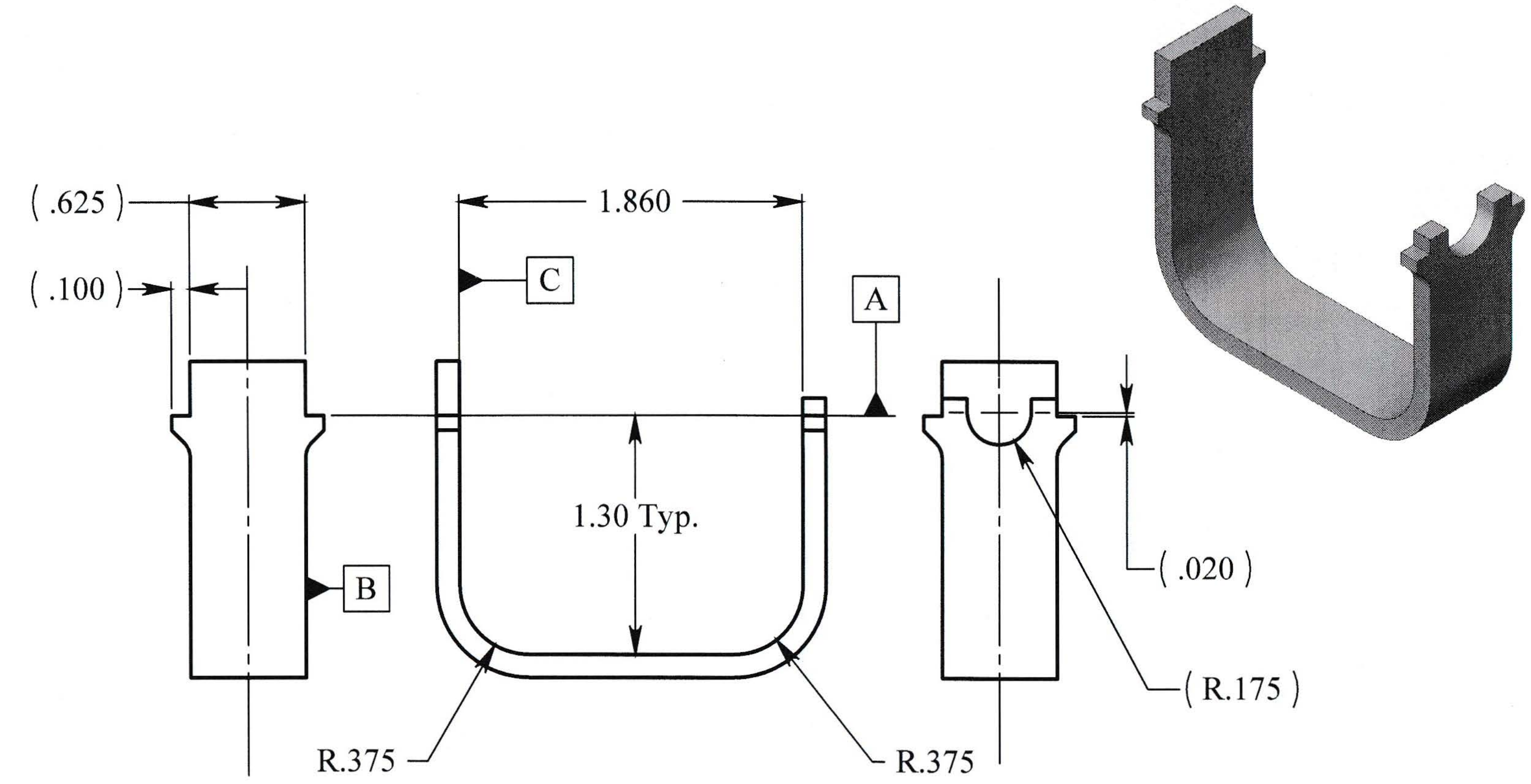


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118	STEN MK II	
		HEAT TREAT Carburize .7 C	PART NAME Trigger	
		HARDNESS HR15N 88 - 92	OPERATION NAME Holes and Bends	
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 20	SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1118 HEAT TREAT None HARDNESS HRB 100 Min. FINISH None	STEN MK II PART NAME Trigger Guard OPERATION NAME Flat Pattern OPERATION NO. 10 — SCALE 1:1

Proprietary and Confidential



Dimensions are in Inches

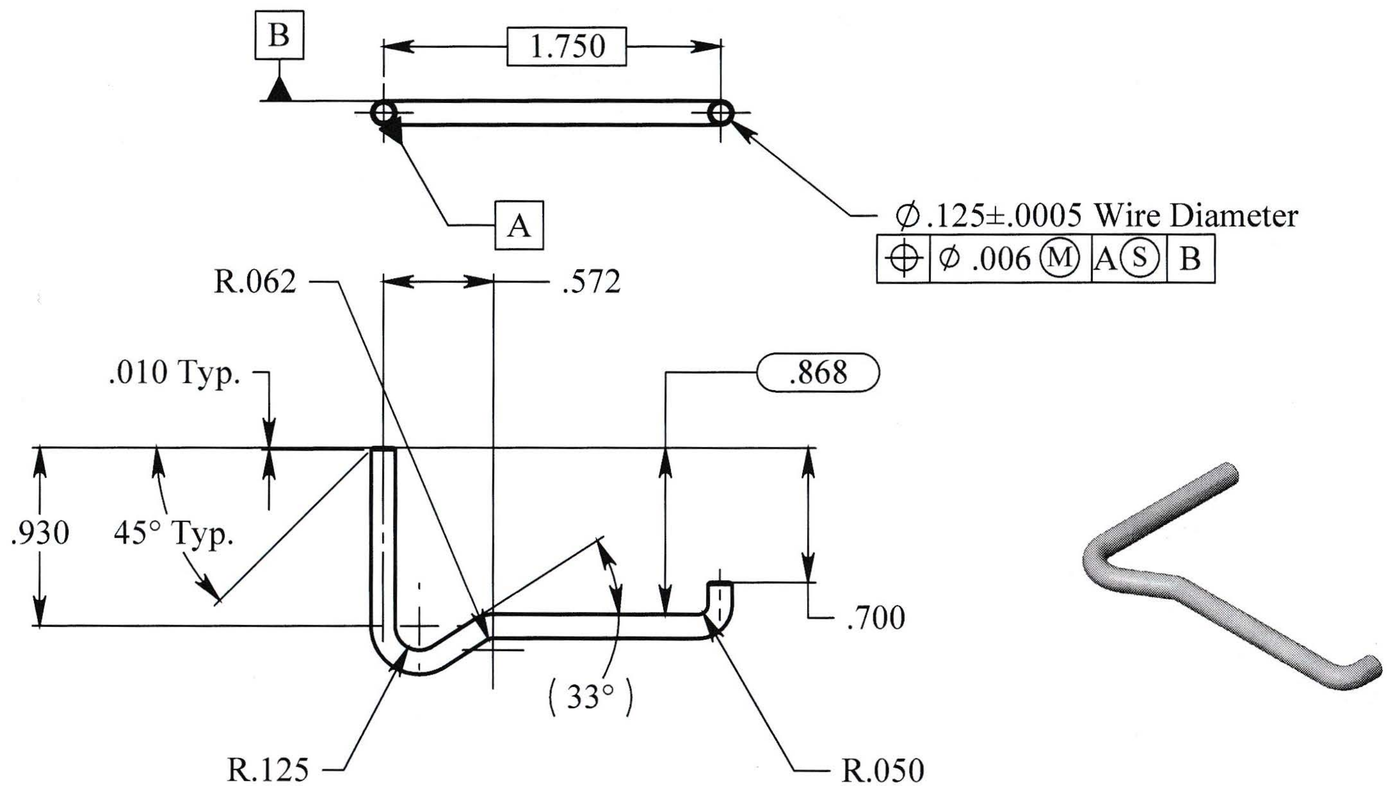
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1118 Ref.	STEN MK II
HEAT TREAT None	PART NAME Trigger Guard
HARDNESS HRB 100 Min.	OPERATION NAME Formed
FINISH None	OPERATION NO. 20 — SCALE 1:1



Dimensions are in Inches

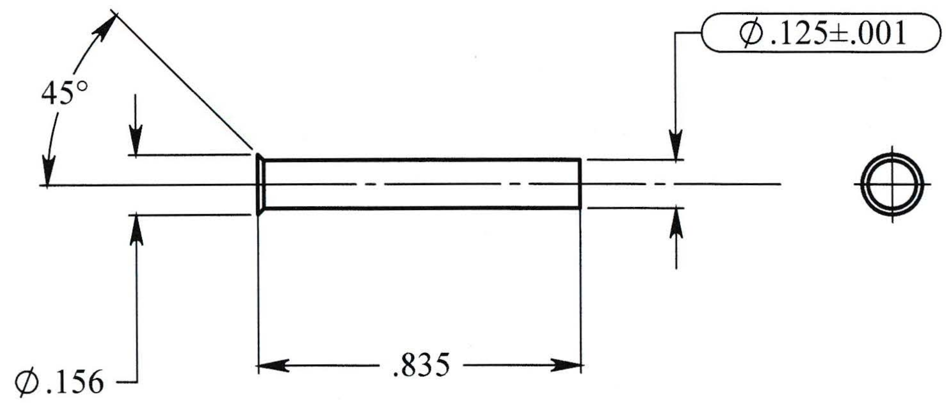
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX

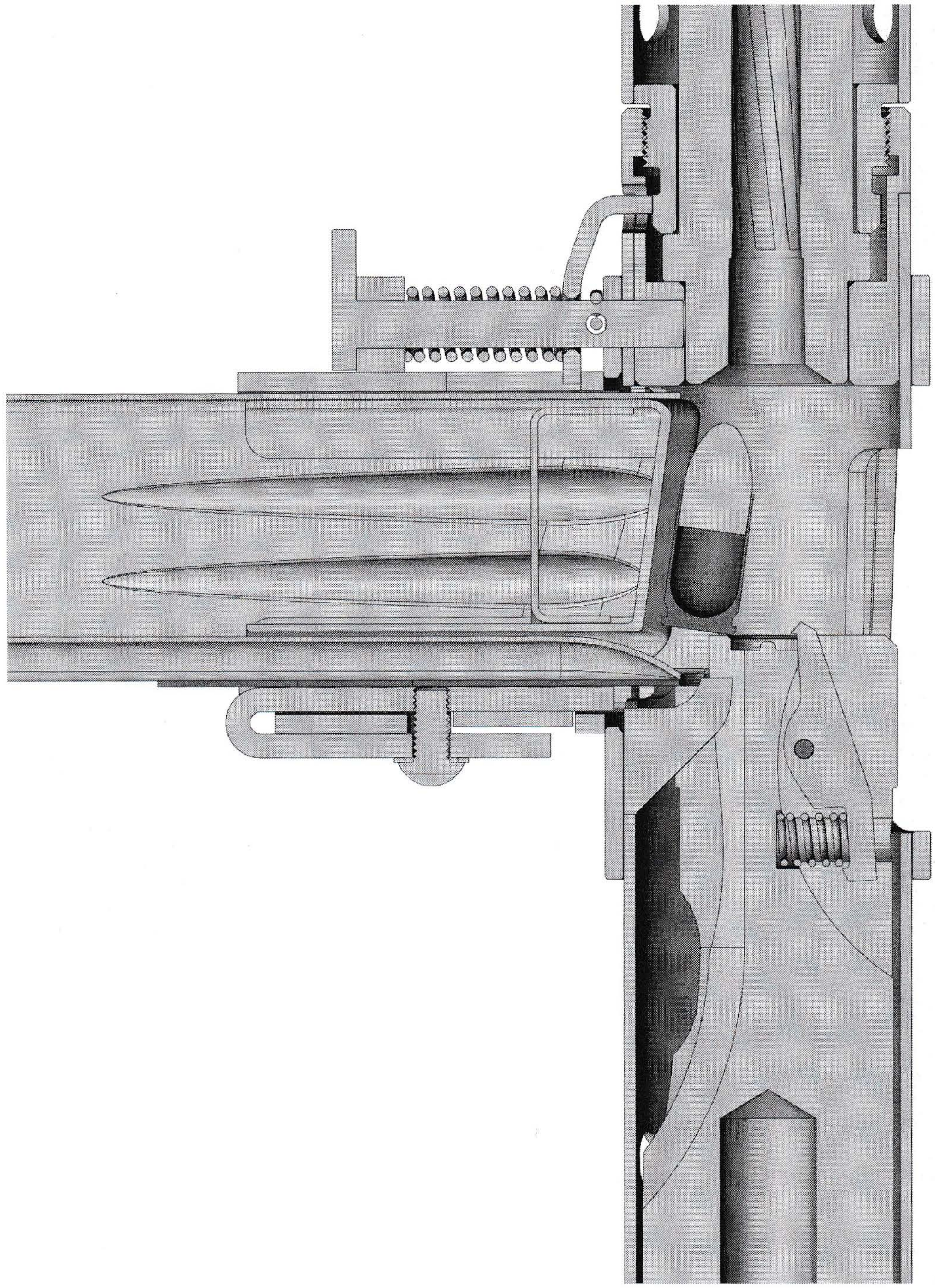
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL AISI 1095	STEN MK II
HEAT TREAT Neutral Salt Harden	PART NAME Trigger Pivot Pin
HARDNESS HRC 48 - 53	OPERATION NAME
FINISH Black Oxide	OPERATION NO. SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL AISI 1095	STEN MK II
		HEAT TREAT None	PART NAME Trigger Stop Pin
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. — SCALE 2:1



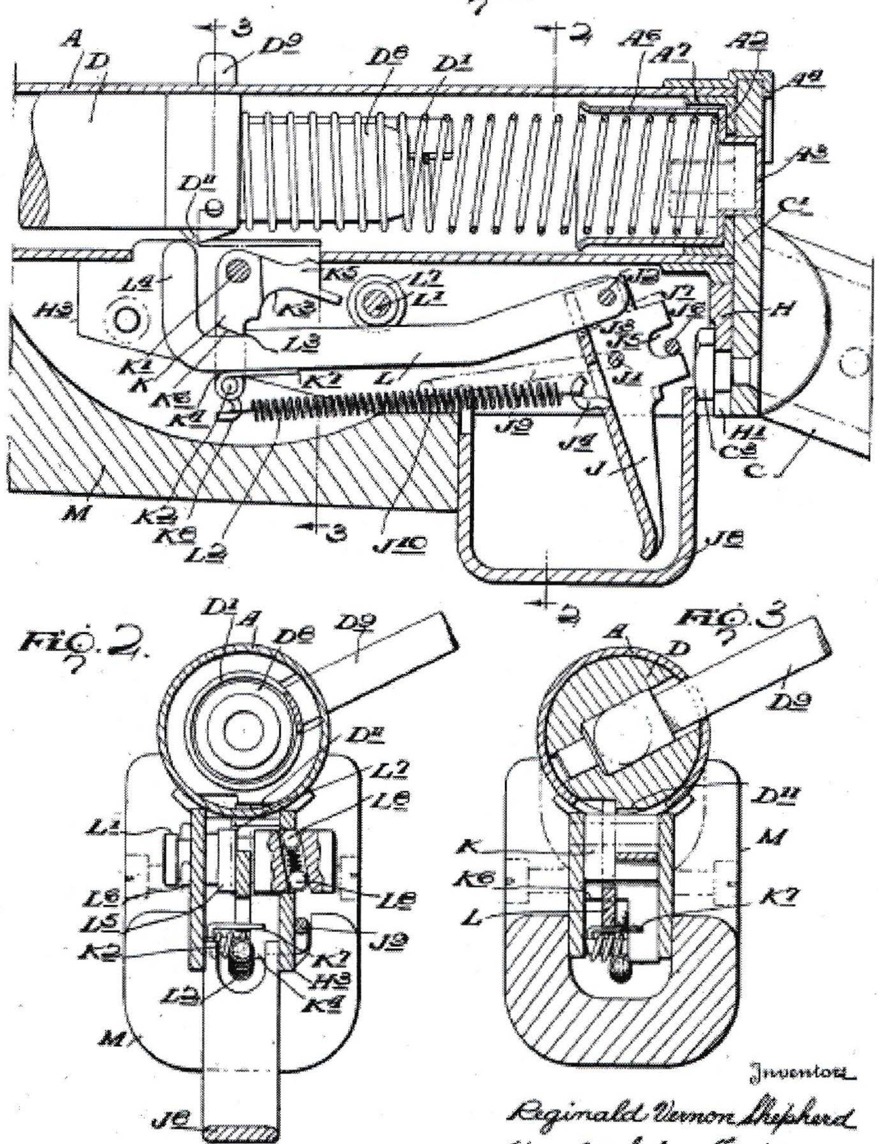
Appendix I
STEN Patent History

Aug. 7, 1945. R. V. SHEPHERD ET AL **2,381,521**

TRIGGER MECHANISM

Filed Sept. 9, 1942

FIG. 1.



Inventors

Reginald Vernon Shepherd

Harold John Turpin

By Loyd Hall Sutton

Attorney

UNITED STATES PATENT OFFICE

2,381,521

TRIGGER MECHANISM

Reginald Vernon Shepherd and Harold John Turpin, London, England

Application September 9, 1942, Serial No. 457,792
In Great Britain April 17, 1941

2 Claims. (Cl. 42—3)

This invention relates to machine guns or rifles, and has, as its main object, to simplify the construction thereof, so as to facilitate manufacture by mass production methods. Whilst not limited thereto, the invention is particularly applicable to machine carbines, i. e., short-barrel machine guns.

One object of the invention is to provide an improved trigger mechanism which is simple in action, has relatively few moving parts, and can readily and cheaply be produced by mass production methods. Such an improved trigger mechanism may comprise an actuating lever for transmitting movement of the trigger to the sear, this lever also acting as a member for selecting either automatic or single shot firing of the gun when the trigger is operated. Preferably the actuating lever constitutes the sole operating member between the trigger and the sear.

The invention may be carried into practice in various ways, and one convenient construction of machine carbine in accordance therewith will now be described by way of example with reference to the accompanying drawing in which—

Fig. 1 is a longitudinal sectional view of a construction embodying the invention, the bolt being shown in an intermediate position between the cocked position and the firing position;

Fig. 2 is a transverse section taken on the line 2—2 of Fig. 1, certain parts being removed; and

Fig. 3 is a transverse section taken on the line 3—3 of Fig. 1, with the mechanism adjusted for automatic firing.

The construction of carbine shown in these figures comprises a tubular metal casing A extending rearwardly from the breech end of the barrel which contains the bolt D which is of substantially cylindrical form and fits within the casing so that it can reciprocate freely. The bolt is relatively heavy, and thus has a large inertia as compared with that of the bullet. Moreover it is normally forced toward the breech by a compression spring D^1—hereinafter referred to as the return spring—disposed between the rear end of the bolt D and the end of the casing. The bolt is not locked during firing and is thus moved rearwardly by the backward thrust of the cartridge following firing, the inertia of the bolt and the strength of the return spring D^1 ensuring sufficient time delay for the bullet to leave the barrel before there is an appreciable opening between the bolt and the barrel.

The rear end of the bolt has a shank D^2 of reduced diameter for insertion into the front end of the helical return spring D^1. In the neighbourhood of the shoulder thus formed, there is a transverse hole to receive the shank of a cocking handle D^3 which projects through a slot in the casing A.

The rear end of the casing A is open and the rear abutment of the spring D^1 is constituted by a removable cup A^2 which fits within and closes the end of the casing. The cup A^2 is held in position by a front end plate C^1 on the removable butt part of which is shown at C and at the same time acts as a retaining catch for the butt. The cup A^2 has a rearwardly projecting boss or spigot A^3 which engages in a hole in the butt plate C^1 so as to prevent further rotational movement of the plate when it has been positioned on the end of the casing. The butt plate C^1 also has a pin C^2 to engage in a slot H^1 in the rear wall H of a trigger mechanism casing attached to the underside of the casing A, the arrangement being such that the pin C^2 enters the slot H^1 when the plate C^1 is inclined (in a plane perpendicular to the barrel axis) to its normal position. Rotation of the butt to bring the hole in the butt plate C^1 into alignment with the boss A^3 locks the pin and slot connection and at the same time brings the upper edge of the plate C^1 under an overhung flange A^4 fixed to or forming part of the main casing. The pin and slot connection C^2—H^1 in conjunction with the overhung flange A^4 thus prevent rearward movement of the plate C^1, and therefore of the abutment cup A^2 of the return spring, whilst the boss A^3 on the cup prevents unlocking rotational movement of the butt plate. To release the butt, it is only necessary to press the outer surface of the boss A^3 of the cup, which is accessible through the hole in the plate C^1, and at the same time to rotate the butt.

In order to prevent any tendency which the return spring may have to buckle or to rub against the walls of the casing, the cup A^2 has a forwardly projecting cylindrical skirt A^6 with a flared forward end. If desired the skirt and the cup may be formed separately, the skirt being in the form of a cylinder with its rear end extending into the cup, fullered and fastened to the inside wall of the cup, for example by spot welding or by riveting.

Preferably, as shown in Figure 1, the rear surface of the cup A^2 abuts against a removable cap A^7 which closes the end of the main casing and is held in position by the front end plate of the removable butt. The cap A^7 has a central hole through which the boss A^3 projects to engage in the hole in the butt plate C^1. The cap A^7 retains the cup A^2 and associated sleeve A^6 in the end of

the casing when the butt plate C^1 is removed by pressing the spigot A^3 and rotating the butt C as described above.

The trigger mechanism casing is mounted on the underside and at the rear end of the main casing and consists of a pair of parallel vertical side walls H^2H^3, having their upper edges welded or otherwise fixed to the main casing, and the rear wall H containing, as has already been described, the slot H^1 for the fixing pin on the butt plate. The mechanism itself comprises a trigger J pivoted at J^1 between the side walls near the rear edge thereof, a sear K pivoted at K^1 between the walls near the front edge thereof, and an actuating lever L pivoted at J^2 on the trigger J and extending forwardly therefrom so as to constitute the sole operating member between the trigger J and the sear K and also to act, in a manner to be described, as a member for selecting single shot or automatic firing of the carbine when the trigger is pressed. In addition the mechanism includes a member L^1 for controlling the selection by the actuating lever L, a tension spring L^2 extending between the trigger J and the sear K, and a bell crank lever K^2 pivoted on the sear for transmitting force exerted by the spring to the actuating lever.

The trigger J comprises a stamping bent so as to have a cross-section of substantially channel form in order to give it rigidity, the sides of the channel tapering from a maximum width near the upper part of the trigger the pivot J^1 at which comprises a horizontal pin supported in holes in the side walls of the mechanism casing, to a minimum width at the lower operating part of the trigger. At the upper end of the trigger the web is cut away at J^3 to provide a clearance space for the lever L the pivot J^2 for which is fixed in the sides of the channel. A part J^4 of the web below the pivot J^1 is stamped out to form a hook for the tension spring L^2 which extends forwardly and thus tends to move the trigger in a clockwise direction about its pivot, that is, towards the "off" position. The rear edges of the sides of the channel, at their widest parts, are slotted as indicated at J^5 and the sides of the slots co-operate with a fixed transverse pin J^6 extending between the sides H^2H^3, to act as stops for limiting pivotal movement of the trigger J in each direction. Ears J^7 are also stamped out of the sides of the channel and are bent outwardly so as to engage the inner surfaces of the walls H^2H^3 and thus to centre the trigger between the walls.

The trigger guard J^8 consists of a metal strip having a width equal to the distance between the inner surfaces of the walls H^2H^3 and bent into substantially U-shape. The ends of the strip are inserted between the walls and are welded or otherwise fixed in position so that they also act as distance pieces for maintaining the lower edges of the side walls the correct distance apart. The trigger guard is positioned so that the rear limb is close to the back plate H and the strip thus protects and in part closes the lower edge of the trigger casing. The end of the trigger casing in front of the front limb of the guard is closed by means of a hand grip of wood M, or of a moulded material such as the material sold under the registered trade-mark "Bakelite," which covers the forward part of the trigger casing and part of the lower surface of the main casing A, this grip being held in place by screw threaded studs. The hand grip M when in position, also prevents withdrawal of the pivot pins J^1 and K^1 for the trigger J and the sear K, the pin J^1, since its ends are not normally covered by the hand grip M, being arranged to project from one side wall of the casing and being bent over, as indicated by the broken line J^9 in Figure 1, so as to extend substantially along the outside of the wall H^3 to a point beneath the hand grip M. Preferably the end of the extension of the pin is turned inwardly so as to engage in a hole or recess J^{10} in the side wall H^3.

The sear K consists of a two-armed bell crank lever pivoted between the side walls so that the upper arm K^3 extends rearwardly and substantially horizontally, whilst the lower arm K^4 extends downwardly. Rotation of the sear in a counter-clockwise direction thus tends to move a nose K^5 on the upper surface of the horizontal arm through an aperture in the underside of the main casing A into the path of a lug D^{11} on the underside of the bolt. The lower end of the arm K^4 is of reduced width so as to form a "step" K^6 about half way between the pivot K^1 and the end of the arm. This step constitutes a projection or lug which normally engages in a notch L^3 in the lever L so that the longitudinal forward movement of lever L as the trigger J is depressed causes clockwise rotation of the sear K about its pivot to lower the nose K^5 and thus release the bolt D.

The lever L extends forwardly beyond the notch L^3 and is bent upwardly to form a nose L^4 so that normally the end thereof lies in the path of the lug D^{11} on the blot, the end being rounded so that it does not act as a catch to prevent reciprocating movement of the bolt. The lug D^{11} does, however, when it engages the nose L^4, cause downward movement thereof, that is, rotation of the lever L in a counter-clockwise direction about its pivot J^2, the downward movement being sufficient to free the step K^6 from the notch L^3. The sear thus returns to its operative position automatically and even though the trigger may still be depressed, engages the lug D^{11} as the bolt is moved forwardly by the return spring D^1 after the recoil following firing. As thus far described the trigger mechanism is set for single shot firing of the gun.

The arm K^4 of the sear carries near its end a horizontal pivot pin for the bell crank lever, K^2, which may comprise a stiff spring steel wire coiled to form the lever pivot bearing, with one arm K^7 bent to engage the under surface of the lever L whilst the other arm K^8 is bent to form an attachment hook for the forward end of the tension spring L^2. This spring thus serves three purposes, namely as a return spring for both the trigger J and the sear K and also as a return spring for the actuating lever L since, due to the upward pressure exerted on the underside of the lever by the arm K^7, the upper surface is maintained in contact with the "step" K^6 on the sear and the lever is moved upwardly following depression thereof by the lug D^{11}.

In order that the lever L may also act as a selecting member for automatic and single shot firing, the lug D^{11} is, as shown most clearly in Figures 2 and 3, unsymmetrically arranged so that by transverse movement of the forward end of the actuating lever, the nose L^4 can be brought into a position in which it is not engaged by the lug D^{11} during reciprocation of the bolt. Since with the lever in this position the connection between the lever L and the sear K is not tripped, the bolt is free to move backwards and forwards as long as the trigger J is held depressed, and the gun fires automatically.

Selecting movement of the lever L is effected by a transverse pin L^1 (Figure 2) which is supported by the walls H^2 and H^3, so that it can slide longitudinally between two limiting positions respectively determined by a collar L^5 formed on the pin and by a split ring L^6 in an annular groove, the collar and the ring being on opposite sides of the wall H^3. The pin L^1 has an annular groove L^7 which constitutes a guide channel for the lever L so that longitudinal movement of the pin causes transverse movement of the lever between two positions in which the nose L^4 is respectively in the path and out of the path of the lug D^{11}. The pin is held in each of its two positions by ball catches L^8 arranged so that the balls engage the edges of the side wall H^3.

It is to be understood that the specific constructions described above are by way of example only and that the form of the individual components may be varied as necessary within the scope of the invention as defined in the appended claims.

We claim as our invention:

1. In an automatic firearm having a bolt which reciprocates automatically on firing, a trigger mechanism comprising a trigger, a pivoted sear having one arm for holding the bolt in the cocked position and a projection on the other arm, an actuating lever, a notch in said lever arranged to engage said projection, said lever being pivoted at its rear end on the trigger so that operation of the trigger causes said lever to move forwardly to rotate the sear through the medium of said projection and notch and release the bolt, a bell-crank lever mounted on said other arm of the sear, one arm of the bell crank lever being arranged to engage said actuating lever, a spring connected between the other arm of the bell-crank lever and the trigger so that the first-mentioned arm of the bell-crank lever exerts pressure on said actuating lever to force said notch into contact with said projection, a lug on the bolt, and selecting means which can be operated to move said actuating lever into a position where it is struck by said lug to disengage said notch and projection against the action of said bell-crank lever and thus release the sear.

2. In an automatic firearm having a bolt which reciprocates automatically on firing, a trigger mechanism comprising a casing, a trigger, a pivoted sear having one arm for holding the bolt in the cocked position and a projection on the other arm, an actuating lever, a notch in said lever arranged to engage said projection, said lever being pivoted at its rear end on the trigger so that operation of the trigger causes said lever to move forwardly to rotate the sear through the medium of said projection and notch and release the bolt, an upturned forward end on said lever, a bell-crank lever mounted on said other arm of the sear, one arm of the bell crank lever being arranged to engage said actuating lever, a spring connected between the other arm of the bell-crank lever and the trigger so that the first-mentioned arm of the bell-crank lever exerts upward pressure on said actuating lever to force said notch into engagement with said projection, a lug on the bolt, and a transverse selector pin slidably mounted in said casing and engaging said actuating lever, which pin can be moved to shift said actuating lever transversely into a position in which said upturned forward end is struck by said lug to disengage said notch and projection against the action of the bell-crank lever and thus release the sear.

REGINALD VERNON SHEPHERD.
HAROLD JOHN TURPIN.

Appendix II
Excel Screen Shots for Determining Cartridge Impulse

The following screen shots will assist you set up your own Excel spreadsheet for determining the impulse of a cartridge given its Pressure vs. Time curve as in Chapter II.

C14 =(B14+B13)/2

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | **Data Analyzed - Bullet** | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

D14 f_x =(C14*(A14-A13)/1000*$D$5)

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | **Data Analyzed - Bullet** | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

Excel Note: Placing the cursor at the end of a variable and pressing the F4 key allows the operator to copy that variable down a column without it changing. In this case we wish to copy D5 in the column without changing. Excel inserts a "$" symbol before and after the letter of the box being copied when the F4 key is selected.

E14 =(D14*32.2)/($D$2/7000+$D$3/7000*0.5)

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | **Data Analyzed - Bullet** | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

F14 =F13+E14

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | Data Analyzed - Bullet | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

G14 f_x =(F14+F13)/2*(A14-A13)/1000*12

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | Data Analyzed - Bullet | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

H14 =H13+G14

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | **Data Analyzed - Bullet** | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

I14 f_x =G14+I13

	A	B	C	D	E	F	G	H	I
1	9mm Pistol Cartridge								
2	Typical Projectile Weight (grains) =			115.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.354					
5	Cartridge Area (in2) =			0.098					
6	Cartridge Length =			0.715					
7									
8	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	Distance in the Barrel
9									
10	0	0	0	0.0000	0.0	0.0	0	0	0.715
11	0.0001	2176	1,088	0.0000	0.0	0.0	0.000	0.000	0.715
12	0.0011	2320	2,248	0.0002	0.4	0.4	0.000	0.000	0.715
13	0.0039	2512	2,416	0.0007	1.3	1.7	0.000	0.000	0.715
14	0.0073	2763	2,638	0.0009	1.7	3.4	0.000	0.000	0.715
15	0.0114	3090	2,927	0.0012	2.3	5.7	0.000	0.000	0.715
16	0.0161	3510	3,300	0.0015	2.9	8.6	0.000	0.001	0.716
17	0.0214	4043	3,777	0.0020	3.8	12.3	0.001	0.001	0.716
18	0.0270	4701	4,372	0.0024	4.6	16.9	0.001	0.002	0.717
19	0.0330	5500	5,101	0.0030	5.8	22.7	0.001	0.004	0.719
20	0.0393	6460	5,980	0.0037	7.1	29.8	0.002	0.006	0.721
21	0.0458	7592	7,026	0.0045	8.6	38.4	0.003	0.008	0.723
22	0.0524	8903	8,248	0.0054	10.2	48.6	0.003	0.012	0.727
23	0.0591	10397	9,650	0.0064	12.2	60.7	0.004	0.016	0.731
24	0.0658	12061	11,229	0.0074	14.1	74.9	0.005	0.022	0.737
25	0.0726	13877	12,969	0.0087	16.6	91.5	0.007	0.029	0.744
26	0.0794	15813	14,845	0.0099	19.0	110.4	0.008	0.037	0.752
27	0.0861	17821	16,817	0.0111	21.2	131.6	0.010	0.047	0.762
28	0.0929	19852	18,837	0.0126	24.1	155.7	0.012	0.058	0.773
29	0.0997	21843	20,848	0.0140	26.7	182.4	0.014	0.072	0.787
30	0.1065	23734	22,789	0.0153	29.1	211.5	0.016	0.088	0.803

Data | **Data Analyzed - Bullet** | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

D76 =SUM(D10:D74)

	A	B	C	D	E	F	G	H	I
49	0.1698	27244	27,564	0.0174	33.2	539.5	0.040	0.371	1.086
50	0.1763	26475	26,860	0.0172	32.8	572.3	0.043	0.414	1.129
51	0.1830	25597	26,036	0.0172	32.8	605.1	0.047	0.462	1.177
52	0.1899	24628	25,113	0.0171	32.6	637.7	0.051	0.513	1.228
53	0.1972	23586	24,107	0.0173	33.1	670.8	0.057	0.570	1.285
54	0.2047	22487	23,037	0.0170	32.5	703.3	0.062	0.632	1.347
55	0.2126	21346	21,917	0.0170	32.6	735.8	0.068	0.700	1.415
56	0.2210	20175	20,761	0.0172	32.8	768.6	0.076	0.776	1.491
57	0.2298	18988	19,582	0.0170	32.4	801.0	0.083	0.859	1.574
58	0.2393	17795	18,392	0.0172	32.8	833.8	0.093	0.952	1.667
59	0.2493	16607	17,201	0.0169	32.3	866.2	0.102	1.054	1.769
60	0.2601	15431	16,019	0.0170	32.5	898.7	0.114	1.169	1.884
61	0.2718	14276	14,854	0.0171	32.7	931.4	0.128	1.297	2.012
62	0.2843	13150	13,713	0.0169	32.2	963.6	0.142	1.439	2.154
63	0.2980	12057	12,604	0.0170	32.5	996.1	0.161	1.600	2.315
64	0.3130	11004	11,531	0.0170	32.5	1,028.6	0.182	1.783	2.498
65	0.3294	9994	10,499	0.0169	32.4	1,061.0	0.206	1.988	2.703
66	0.3476	9032	9,513	0.0170	32.5	1,093.5	0.235	2.224	2.939
67	0.3676	8119	8,576	0.0169	32.2	1,125.7	0.266	2.490	3.205
68	0.3900	7259	7,689	0.0170	32.4	1,158.1	0.307	2.797	3.512
69	0.4152	6452	6,856	0.0170	32.5	1,190.6	0.355	3.152	3.867
70	0.4435	5700	6,076	0.0169	32.3	1,222.9	0.410	3.562	4.277
71	0.4756	5003	5,352	0.0169	32.3	1,255.2	0.477	4.039	4.754
72	0.5124	4361	4,682	0.0170	32.4	1,287.6	0.561	4.600	5.315
73	0.5546	3774	4,068	0.0169	32.3	1,319.9	0.660	5.261	5.976
74	0.5662	3635	3,705	0.0042	8.1	1,328.0	0.184	5.445	6.160
75									
76		**28,793**		**0.695**	**1,328**		**5.445**		
77		Max		Impulse	Bullet Vel.		Bullet Travel		
78									
79									
80									

Data | Data Analyzed - Bullet | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

E76 | =SUM(E10:E74)

	A	B	C	D	E	F	G	H	I
49	0.1698	27244	27,564	0.0174	33.2	539.5	0.040	0.371	1.086
50	0.1763	26475	26,860	0.0172	32.8	572.3	0.043	0.414	1.129
51	0.1830	25597	26,036	0.0172	32.8	605.1	0.047	0.462	1.177
52	0.1899	24628	25,113	0.0171	32.6	637.7	0.051	0.513	1.228
53	0.1972	23586	24,107	0.0173	33.1	670.8	0.057	0.570	1.285
54	0.2047	22487	23,037	0.0170	32.5	703.3	0.062	0.632	1.347
55	0.2126	21346	21,917	0.0170	32.6	735.8	0.068	0.700	1.415
56	0.2210	20175	20,761	0.0172	32.8	768.6	0.076	0.776	1.491
57	0.2298	18988	19,582	0.0170	32.4	801.0	0.083	0.859	1.574
58	0.2393	17795	18,392	0.0172	32.8	833.8	0.093	0.952	1.667
59	0.2493	16607	17,201	0.0169	32.3	866.2	0.102	1.054	1.769
60	0.2601	15431	16,019	0.0170	32.5	898.7	0.114	1.169	1.884
61	0.2718	14276	14,854	0.0171	32.7	931.4	0.128	1.297	2.012
62	0.2843	13150	13,713	0.0169	32.2	963.6	0.142	1.439	2.154
63	0.2980	12057	12,604	0.0170	32.5	996.1	0.161	1.600	2.315
64	0.3130	11004	11,531	0.0170	32.5	1,028.6	0.182	1.783	2.498
65	0.3294	9994	10,499	0.0169	32.4	1,061.0	0.206	1.988	2.703
66	0.3476	9032	9,513	0.0170	32.5	1,093.5	0.235	2.224	2.939
67	0.3676	8119	8,576	0.0169	32.2	1,125.7	0.266	2.490	3.205
68	0.3900	7259	7,689	0.0170	32.4	1,158.1	0.307	2.797	3.512
69	0.4152	6452	6,856	0.0170	32.5	1,190.6	0.355	3.152	3.867
70	0.4435	5700	6,076	0.0169	32.3	1,222.9	0.410	3.562	4.277
71	0.4756	5003	5,352	0.0169	32.3	1,255.2	0.477	4.039	4.754
72	0.5124	4361	4,682	0.0170	32.4	1,287.6	0.561	4.600	5.315
73	0.5546	3774	4,068	0.0169	32.3	1,319.9	0.660	5.261	5.976
74	0.5662	3635	3,705	0.0042	8.1	1,328.0	0.184	5.445	6.160
75									
76		**28,793**		**0.695**	**1,328**		**5.445**		
77		Max		Impulse	Bullet Vel.		Bullet Travel		
78									
79									
80									

Data | **Data Analyzed - Bullet** | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

G76 =SUM(G10:G74)

	A	B	C	D	E	F	G	H	I
49	0.1698	27244	27,564	0.0174	33.2	539.5	0.040	0.371	1.086
50	0.1763	26475	26,860	0.0172	32.8	572.3	0.043	0.414	1.129
51	0.1830	25597	26,036	0.0172	32.8	605.1	0.047	0.462	1.177
52	0.1899	24628	25,113	0.0171	32.6	637.7	0.051	0.513	1.228
53	0.1972	23586	24,107	0.0173	33.1	670.8	0.057	0.570	1.285
54	0.2047	22487	23,037	0.0170	32.5	703.3	0.062	0.632	1.347
55	0.2126	21346	21,917	0.0170	32.6	735.8	0.068	0.700	1.415
56	0.2210	20175	20,761	0.0172	32.8	768.6	0.076	0.776	1.491
57	0.2298	18988	19,582	0.0170	32.4	801.0	0.083	0.859	1.574
58	0.2393	17795	18,392	0.0172	32.8	833.8	0.093	0.952	1.667
59	0.2493	16607	17,201	0.0169	32.3	866.2	0.102	1.054	1.769
60	0.2601	15431	16,019	0.0170	32.5	898.7	0.114	1.169	1.884
61	0.2718	14276	14,854	0.0171	32.7	931.4	0.128	1.297	2.012
62	0.2843	13150	13,713	0.0169	32.2	963.6	0.142	1.439	2.154
63	0.2980	12057	12,604	0.0170	32.5	996.1	0.161	1.600	2.315
64	0.3130	11004	11,531	0.0170	32.5	1,028.6	0.182	1.783	2.498
65	0.3294	9994	10,499	0.0169	32.4	1,061.0	0.206	1.988	2.703
66	0.3476	9032	9,513	0.0170	32.5	1,093.5	0.235	2.224	2.939
67	0.3676	8119	8,576	0.0169	32.2	1,125.7	0.266	2.490	3.205
68	0.3900	7259	7,689	0.0170	32.4	1,158.1	0.307	2.797	3.512
69	0.4152	6452	6,856	0.0170	32.5	1,190.6	0.355	3.152	3.867
70	0.4435	5700	6,076	0.0169	32.3	1,222.9	0.410	3.562	4.277
71	0.4756	5003	5,352	0.0169	32.3	1,255.2	0.477	4.039	4.754
72	0.5124	4361	4,682	0.0170	32.4	1,287.6	0.561	4.600	5.315
73	0.5546	3774	4,068	0.0169	32.3	1,319.9	0.660	5.261	5.976
74	0.5662	3635	3,705	0.0042	8.1	1,328.0	0.184	5.445	6.160
75									
76		**28,793**		**0.695**	**1,328**		**5.445**		
77		Max		Impulse	Bullet Vel.		Bullet Travel		
78									
79									
80									

Data | Data Analyzed - Bullet | PT Curve | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

Appendix III
Excel Screen Shots for Determining Firearm Round Per Minute Level Assuming Frictional Drag and Including Elasticity

The following screen shots will assist you set up your own Excel spreadsheet for determining the functional performance of a blowback firearm assuming frictional drag and including elasticity as in Chapter III.

J4 =E6+E7+E8+E9/3

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J5 | f_x =J4/J10

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J6 | f_x =POWER(E5,2)*0.5/J5

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J7 =SQRT((E12*E12)+(2*E12*D19)+(D19*D19)+(E13*E5*E5/J5))

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J8 =(E12+(E13*E10)-D19)/E13

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J9 =J5*G43*G43*E15*E15/E13

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J12 =SQRT(J5/E13)*(ASIN((E13*E10+E12+D19)/J7)-ASIN((E12+D19)/J7))

	A	B	C	D	E	F	G	H	I	J	K
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey		
2											
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:				
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40	
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036	
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7	
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27	
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83	
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00	
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4	
11	Bolt Dynamic Friction Coef =			σ	0.250						
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481	
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511	
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605	
15	Elasticity Coefficient =			E	0.00						
16											
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)	
18	0.0000	0	0	0	0	0	0	0	0	0	
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1	
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2	
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5	

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J13 | =((ATAN((E10-J8)*(SQRT(-1*E10*E10+2*J8*E10+J9)/(E10*E10-2*J8*E10-J9))))-ATAN(J8/J9*SQRT(J9)))*SQRT(J5/E13)*-1

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready NUM

J14 | =60/(J12+J13)

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

A19 | f_x =J12/25

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

B19 | f_x =E11*J4*COS(E14*3.1415/180)

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

C19 f_x =J4*SIN(E14*3.1415/180)

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

D19 f_x =SUM(B19:C19)

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

E19 =($J$7*SIN((SQRT($E$13/$J$5)*A19)+ASIN(($E$12+D19)/$J$7))-$E$12-D19)/$E$13

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready NUM

F19 =(E19-E18)/(A19-A18)

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

G19 | =F19+G18

	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

H19

```
=((ATAN((I19-$J$8)*(SQRT(-1*I19*I19+2*$J$8*I19+$J$9)/(I19*I19-2*$J$8*I19-$J$9))))-ATAN($J$8/$J$9*SQRT($J$9)))*SQRT($J$5/$E$13)*-1
```


	A	B	C	D	E	F	G	H	I	J
1	STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

NUM

I19 | =E10/25

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

J19 | =(I19-I18)/(H19-H18)

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts		Wt (lbs) =	1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

A20 | f_x =J12/25+A19

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

C20 | f_x =C19

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

F20 =(E20-E19)/(A20-A19)-G19

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
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17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

H20 =((ATAN((I20-$J$8)*(SQRT(-1*I20*I20+2*$J$8*I20+$J$9)/(I20*I20-2*$J$8*I20-$J$9))))-ATAN($J$8/$J$9*SQRT($J$9)))*SQRT($J$5/$E$13)*-1

	A	B	C	D	E	F	G	H	I	J
1	**STEN Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	115		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.40
5	Impulse (lb-sec) =			I	0.695		Recoiling Mass Mr =			0.0036
6	Bolt Weight (lbs) =			Wb	1.295		Er (in-lbs) =			66.7
7	Extractor Weight & Spring (lbs) =			We	0.0156		Q Term =			18.27
8	Cocking Handle Weight (lbs)			Wc	0.073		a Term =			7.83
9	Return Spring Weight (lbs)=			Ws	0.045		B Term =			0.00
10	Full Bolt Stroke (in) =			D	5.515		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.55		Calc. Recoil Time T (Sec) =			0.0481
13	Spring Constant (lbs/in) =			K	2.240		Calc. Counter Recoil Tt (sec) =			0.0511
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			605
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0019	0.3	0.0	0.3	0.366	190.4	190.4	0.0096	0.221	23.1
20	0.0039	0.3	0.0	0.3	0.726	-3.6	186.8	0.0136	0.441	55.2
21	0.0058	0.3	0.0	0.3	1.078	-4.0	182.8	0.0166	0.662	71.5

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready NUM

Endnotes

Acknowledgements:

1. "-The Maple Leaf Scrapbook-", No. 3 Cdn. P.R. Group, 1945.

Chapter 1:

2. Thomas B. Nelson, with assistance from Hans B. Lockhoven, *The World's Submachine Guns [machine pistols], Volume I, Developments From 1915–1963* (Alexandria, Va: T.B.N Enterprises, 1963), 489.
3. Peter Laidler, *The Sten Machine Carbine*, (Ontario: Collector Grade Publications, 2000), 31.
4. Ibid, 8.
5. Ibid., 9,23,31,33,35.
6. Nelson, *The World's Submachine Guns,* 489.
7. Ibid.

Chapter 2:

8. Laidler, *The Sten Machine Carbine*, 228.
9. George M. Chinn, *The Machine Gun, Design Analysis of Automatic Firing Mechanisms and Related Components, Volume IV, Parts X and XI* (Washington DC: Bureau of Ordnance, Department of the Navy, 1955), 31.
10. Ibid, 30.
11. QuickLOAD software from Neco, Inc. H. Broemel, 64832 Babenhausen, Germany.
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13. U.S. Army Materiel Command Headquarters, *The Engineering Design Handbook: Gun Series – Gun Tubes AMPC 706-252* (Washington, D.C.: U.S. Army Materiel Command, 1964), 40-46.
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16. Julian S. Hatcher, *Hatcher's Notebook,* (Harrisburg, Pa: The Stackpole Company, 1966), 201-202
17. Ibid.
18. Fred H. Colvin and Ethan Viall, *Manufacture of the Model 1903 Springfield Service Rifle,* (Prescott, Arizona: Wolfe Publishing Co, Inc. 1984), 12.

Chapter 7:

19. Laidler, *The Sten Machine Carbine*, 287.

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20. George Dmitrieff, *Submachine Gun Designer's Notebook,* (Cornville, Arizona: Desert Publications, 1981), 45-66.
21. Laidler, *The Sten Machine Carbine*, 245.

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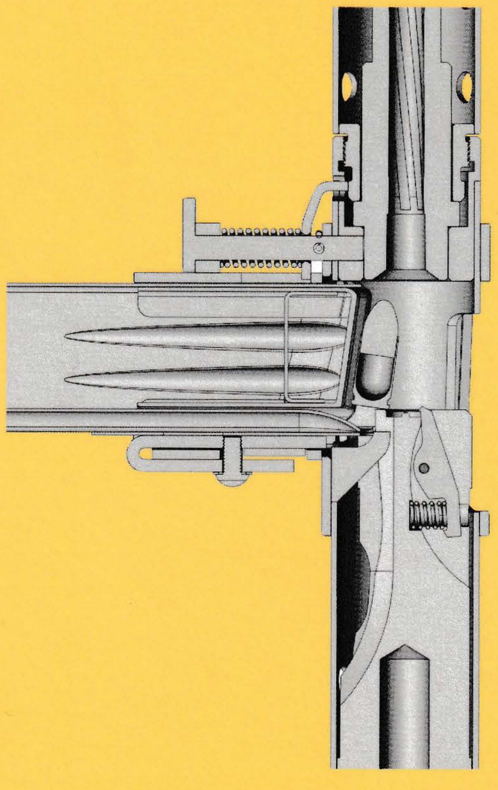
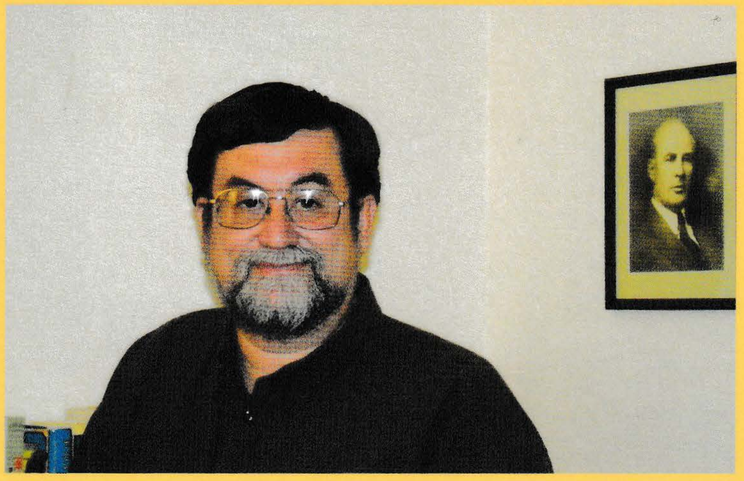
This book was written to interest the reader in the simplicity and the hidden complexity that gun designs exhibit and prompt the imagination of the reader to investigate the field of firearms design further. Reading this book will give the reader:

- Two ways to calculate the round per minute (RPM) firing level of a 9 mm submachine gun using the British STEN as the sample firearm.
- A sample computer simulation using Excel to allow the reader to experiment with different 9mm submachine gun design conditions.
- The full technical data package of a reverse-engineered STEN as individual operation process sheets showing the dimensions of each cut.
- Insight on firearm metallurgy material selection and heat treatment for various common firearm components.
- An explanation of how to analyze and design a gun barrel.
- A resource to find the pressure versus time curve of any cartridge, including any design for a new round (that you conceive of) without the need for expensive test equipment and time.
- The explanation, with illustrations, of how the STEN submachine gun operates.





David Findlay has spent his entire life around firearms and in the field of gun design. His first job was at Remington Arms where he worked 26 years as a designer and firearms acceptance testing. David then worked for Marlin/H&R 1871 as a product designer and later was in charge of the engineering group at H&R 1871. Currently, he is employed by Smith & Wesson as a product engineer. He holds eight firearms patents.

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